THE

JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

[REGISTERED AS A NEWSPAPER.]

VOL. XXVII. No. 680.] LONDON, MAY 23, 1876. [28TH YEAR.] Price 6d.

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FOR THE ENGLISH GOVERNMENT
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Presented by Her Majesty's Government to the French Government,
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In the construction of this Meter, for which the best tin plates only are used, every mechanical contrivance has been taken advantage of successfully to reduce the friction to a minimum, which is amply proved by the fact that they are made to work upon only one-fortieth of an inch pressure. By an improvement also in their construction, a steadier light is obtained, and greater capacity than can be got from any other Meter in the market. No gas can pass under the valves on any back pressure, as is the case with many other Dry Meters.

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ALL METERS ARE UPHELD FOR FIVE YEARS.

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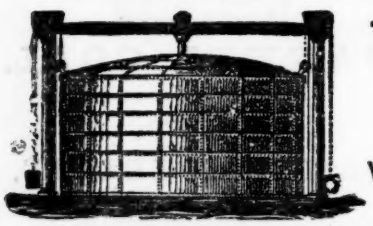

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STATION & CONSUMERS WET OR DRY METERS, STREET & SERVICE MAINS, LAMP COLUMNS & BRACKETS, & WROUGHT-IRON TUBES AND FITTINGS; WROUGHT-IRON ROOFS FOR ANY SIZE OF BUILDINGS.

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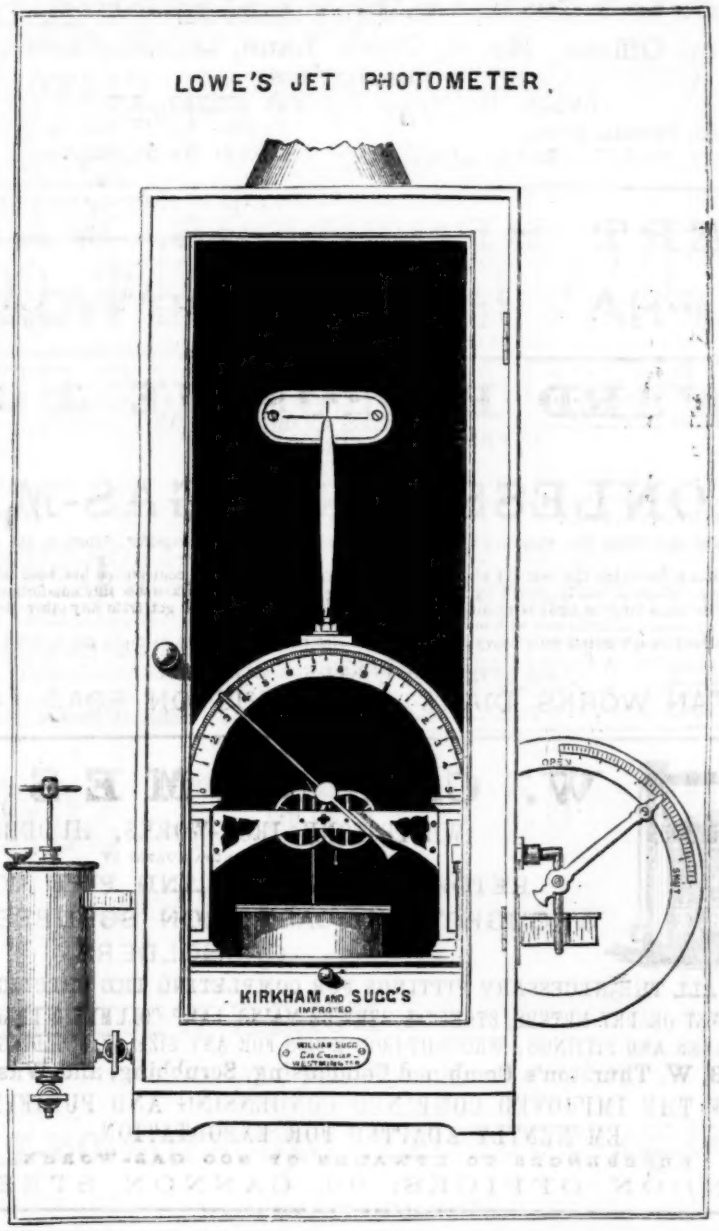
Photometers,

which do not require a Dark Room, with every Fitting accurately made to Gauge, French Polished Bench and Drawers complete, as approved by the Gas Referees.



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Photometers,

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With new external Water-Line Regulator; Improved Micrometer, with Quadrant divided into 45 degrees; Valve, with *pro rata* opening; Improved Ventilator, Purple Glass Height of Flame Measurer; King's Gauge, working on Friction Rollers. In French Polished Pine Case. Diagram for ditto for finding the Illuminating Power in Candles.

PRICE £12 10s. COMPLETE.

Can also be had with additional Scale on Pressure Gauge, to show by inspection the Illuminating Power in Sperm Candles, at a slight extra cost.

NOTE.—When an order is given for a Jet Photometer with this latter addition, it will be necessary to state about the quality of Gas for which it will be used. The range in candles will not be more than three or four.

PRICE LISTS WILL BE FORWARDED POST FREE ON APPLICATION.

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And every description of Gas Machinery.

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ARE NOW PREPARED TO SUPPLY AND ERECT THEIR PATENTED MACHINERY FOR

CHARGING AND DRAWING GAS-RETORTS,

And to enter into arrangements with GAS COMPANIES for its use upon moderate terms of Royalty.

The Patented Machinery has secured the approbation of all Engineers who have visited the MAIDSTONE GAS-WORKS, *where it is in full operation, and may be inspected at any time on application to the Manager.*

The advantages attending its use are—

INCREASED VOLUME OF GAS PER TON.—INCREASED YIELD PER RETORT.—INCREASED BULK OF COKE FOR SALE.—REDUCTION IN LABOUR AND LESS DEPENDENCE ON SKILLED STOKERS.

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WORKS:

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SIZES: ¾ to 12 inches at GLASGOW.

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A LARGE STOCK KEPT, AND PRICES MODERATE.

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LAURENCE POUNTNEY LANE, LONDON, E.C.,

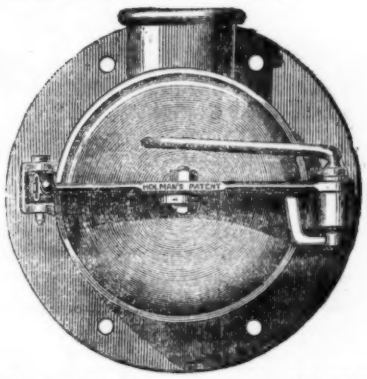
SOLE MAKERS OF

MORTON'S PATENT SELF-SEALING RETORT-LIDS,

WITH

HOLMAN'S NEW PATENT BRACKETED CROSS-BARS,

Anti-Friction Catches and Eccentric Fastenings.



Instantaneous Sealing effected. No Luting. No Duplicate Lids required. Holman's New Self-Sustaining Cross-Bar ensures freedom of joint and maintains parallel position of the Lids.

Since their introduction in 1869, these Patent Retort-Lids have been thoroughly tested, nearly 20,000 being in use at various Gas-Works in London and the Provinces, among which may be mentioned:—

The Gaslight Co., Beckton, where nearly 4000 are in use).
" Gaslight Co., Bow Common.
" Gaslight Co., Silvertown.
" Gaslight Co., Lupus Street.
" London Gaslight Co.
" Independent do.
" Phœnix do.
" South Metropolitan Gaslight Co.
" Commercial do.
" Imperial do.
" West Ham Gas Co.
" Gas-Works, Barnet.

The Gas-Works, Royal Arsenal, Woolwich.
" do. Lower Sydenham.
" do. Brentford.
" Consumers Gas Co., Woolwich.
" Alliance and Dublin Gas-Works.
" Edinburgh do.
" Manchester Corporation do.
" Salford do. do.
" Rochdale do. do.
" Liverpool Gas-Works.
" Birmingham do.
" Birkenhead do.
" Nottingham do.

The Newcastle-on-Tyne Gas-Works.
" Lurgan do.
" Carmarthen Gas-Works.
" Merthyr Tydfil do.
" Windsor do.
" Leeds do.
" St. Albans do.
" Over Darwen do.
" Rotherham do.
" Aylesbury do.
" Bournemouth do.
" Ystrad do.
" Cardiff do.
" Rochester do.

The Keighley Gas-Works.
" Aberdare do.
" Ballymena do.
" Richmond do.
" Stalybridge do.
" Longton do.
" Exeter do.
" Ross do.
" Falmouth do.
" Barrow-in-Furness do.
" Belfast do.
" Wakefield do.
And other Provincial and Foreign Gas-Works.

IMPORTANT TESTIMONIAL.

The Gaslight and Coke Company (Commonly called the Chartered Gas Company), Beckton, North Woolwich, July 2, 1874.

MESSRS. TANGYE BROTHERS AND HOLMAN.

Gentlemen,—In answer to your inquiry respecting the Self-Sealing Lids, I beg to say that they continue to work well, and I have every reason to be satisfied with them.

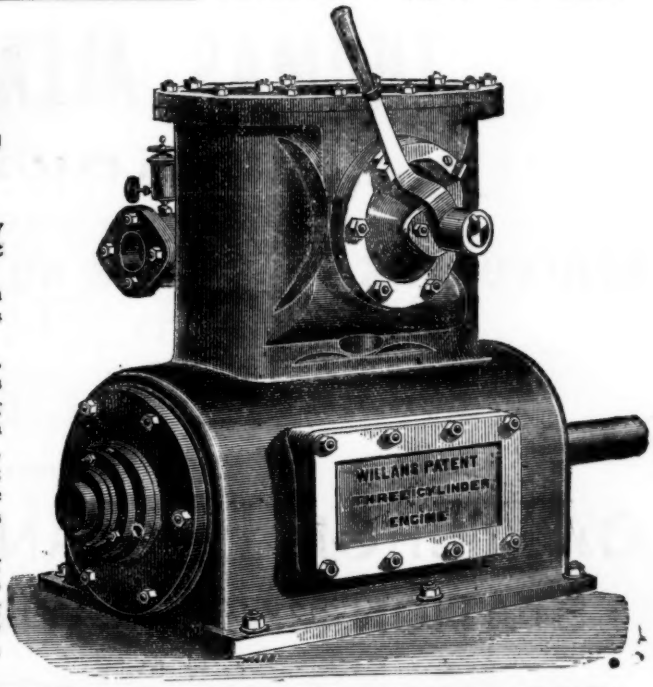
I should be very sorry to return to the old system of Luting, and our stokers here freely acknowledge the benefit to them of the new system.

I am, yours truly, (Signed) G. C. TREWBY.

WILLAN'S PATENT THREE-CYLINDER ENGINE,

ESPECIALLY SUITED TO DRIVE

GAS-EXHAUSTERS.



This Engine is exceedingly simple in construction, unlikely to get out of order, and can be safely driven by the most unskilful.

All the working parts are enclosed in a strong cast-iron casing, so that nothing is to be seen in motion except the ends of the shaft projecting from the sides of the casing.

The Engine consists of three cylinders cast in one piece, parallel to each other. From the bottom end of the cylinders a chamber extends downwards, enveloping the connecting rods and crank-shaft. Upon the side of the cylinders is a valve and lever by which the Engine may be started, stopped, or reversed. The pistons receive steam only on the top side; but, as there are three of them, there is no dead centre. The Engine will stop and start in any position, and no fly-wheel is necessary.

The reversing valve is not attached to any of the working parts, and the Engine may, for this reason, be reversed as easily at full speed as when running slowly. As the working parts are all balanced, the Engine is capable of running at very high speeds, without vibration, and consequently it requires the smallest amount of foundation to fix it.

INDICATED HORSE POWER—At a mean steam pressure of 30 lb. per square inch.	2½ H. P.	4½ H. P.	13 H. P.	16 H. P.	31 H. P.	53 H. P.
Diameter of Cylinder . . . . . inches.	3	4	6	7	8	10
Length from end to end of shaft-bearings . . . . . "	18	25	36	47	49	60
Breadth . . . . . "	12	15	20	22	27	34
Height . . . . . "	19	20	29	40	42	56
Weight of Engine complete. . . . . cwt.	2¼	3½	8	9	10½	31
Diameter of steam-pipe . . . . . inches.	¾	1	1¼	1½	2	2½
Price complete, with Reversing Gear	**£25**	**£35**	**£55**	**£80**	**£110**	**£180**
If fitted with Tangye's Patent Governor . . . . . EXTRA.	£6	£7 10	£9 10	£10	£12 10	£14 10

London 1851. New York, 1853 Paris, 1855. London, 1862.

Dublin, 1865

The SIX MEDALS AWARDED to THOMAS GLOVER for

PATENT DRY GAS-METERS,

The latter being the Highest Medal awarded for Dry Gas-Meters by the Imperial Commissioners for the Universal Exhibition, Paris, 1867.

Paris, 1867.

THOMAS GLOVER & CO.,

DRY GAS-METER MANUFACTURERS,

214 TO 222, ST. JOHN STREET, CLERKENWELL GREEN,

LONDON, E.C.

THOMAS GLOVER & CO.'S PATENT DRY GAS-METERS,

1st, Are a remedy for all the defects of Wet Meters;
2nd, Are suitable for all climates, whether hot or cold;
3rd, Incur no loss of Gas by evaporation;
4th, Cannot become fixed by frost, however severe;
5th, Are the most accurate and unvarying measurers of Gas;
6th, Prevent jumping or unexpected extinction of the Lights;
7th, May be fixed either above or below the level of the Lights;
8th, Cannot be tampered with, without visibly damaging the outer case;
9th, Will last much longer than Wet Meters;
10th, Will not cost more than one-half for repair that Wet or Water Meters do;
Are upheld for five years without charge.

WILLIAM PARKINSON & CO.,

(SUCCESSORS TO SAMUEL CROSLEY,)

COTTAGE LANE, CITY ROAD, LONDON, E.C.

Established 1816.

MANUFACTURERS OF PATENT

WET & DRY GAS-METERS,

STATION-METERS WITH PLANED JOINTS,

GOVERNORS, PRESSURE REGISTERS, GAUGES,

AND EXPERIMENTAL APPARATUS,

STREET-LAMP METERS,

AND REGULATORS FOR AVERAGE METER INDICATION.

METERS FOR MEASURING WATER.

CONTENTS.

Circular to Gas Companies:— PAGE
Metropolitan Gas Affairs . . . 757
Leeds Corporation Gas Undertaking . . . 758
The Gas Accounts of the Rochdale Corporation . . . 758
The Vestry of Chelsea and the Average Meter System . . . 758
Patterson *v.* The Gaslight and Coke Company . . . 758
Silber *v.* Sugg . . . 758
Mr. Lewis Thompson and the Chief Gas Examinership . . . 758

Water and Sanitary Notes:—
The Conference at the Society of Arts . . . 759
Accounts of the Sanitary Manure Department of the Rochdale Corporation . . . 759
Rochdale Corporation Water Accounts . . . 759
The Stockton and Middlesbrough Corporations Water Bill . . . 759

Correspondence:—
The Alleged Nuisance at the Exeter Gas-Works . . . 759
Malam's Process of Gas-Making . . . 760
Simultaneous Lighting of Public Lamps . . . 760

Parliamentary Intelligence:—
Progress of Bills in House of Lords . . . 760
Progress of Bills in House of Commons . . . 760
Burghs (Scotland) Gas Supply Bill . . . 761

Legal Intelligence:—
Supreme Court of Judicature—High Court of Appeal—Chancery Division—Patterson *v.* The Gaslight and Coke Company . . . 761
High Court of Justice—Queen's Bench Division—Sugg *v.* Silber . . . 766

Miscellaneous News:—
Testimonial to the Ex-Governor of The Gaslight and Coke Company . . . 759
Transfer of the Maryport Town and Harbour Gas Company's Works . . . 759
Metropolis Gas Supply . . . 771
Metropolis Water Supply . . . 772
Meeting of The Gaslight and Coke Company . . . 773
Meeting of the Monte Video Gas Company . . . 775
M. Giroud's Gas Verifier . . . 776
Meeting of the Bahia Gas Company . . . 776
West of Scotland Association of Gas Managers . . . 778
Yield of Wells Sunk in the Chalk of the London Basin. By Mr. Edward Easton . . . 782
Trade Reports . . . 783

Register of New Patents:—
Applications for Letters Patent . . . 784
Patents which have passed the Great Seal . . . 784
Patents which have become void . . . 784

TO CORRESPONDENTS.

PITCH.—*You are following the best process for obtaining what you want, but are wasting the most valuable part of the tar, which you might condense.*

E. P. *writes:* "*I have recently had a 50-light meter tested by the Government inspector, who has pronounced it to be 2·5 per cent. fast. Now as the Act specifies that 2 per cent. fast shall be considered correct, ought I, therefore, in making an allowance to the consumer, to deduct only the ·5 or 2·5 per cent. off his bill?*" *The provision, in the clause of the Act referred to, is an instruction to the inspector, but we apprehend that in adjusting an account with a consumer the whole amount of error discovered should be allowed.*

WEST OF SCOTLAND GAS MANAGERS ASSOCIATION.—*Mr. Young, of Clippens, writes to say, that in the report of the proceedings published in our last he is made in one place to say: "There is a process being applied for the extraction of hydrocarbon vapours from shales and coals, by simply compressing them until the vapours separate." The sentence should read: "There is a process being applied for the extraction of hydrocarbon vapours from shale and coal gases, by simply," &c.*

WATER-RENT.—*The Water-Works Clauses Act provides that the rate "shall be payable according to the annual value of the tenement supplied with water, and if any dispute arises as to such value, the same shall be determined by two justices." The terms generally used in recently passed special Acts are, "a rate according to the annual rack-rent, or value, of such dwelling-house or tenement."*

THE JOURNAL OF GAS LIGHTING,
WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, MAY 23, 1876.

Circular to Gas Companies.

THE state of metropolitan gas affairs, at the present moment, is somewhat peculiar and complicated. We have, first of all, the Regulations Bill, with the provisions of which our readers are acquainted, passed a second reading, and referred to a Select Committee, not yet, we think, appointed. We have, further, the Bill of the Chartered Company, embodying some provisions foreign to the Regulations Bill, the preamble of which has been passed by a committee of the House of Commons. Then we have the Bill of the South Metropolitan Company, differing in some respects from both the measures previously mentioned, and which is now before a committee; and, lastly, we have some proposals made by three of the South London Companies to the Metropolitan Board of Works, with a view to their embodiment in an amended Regulations Bill. Some irreverently describe the present condition of things as a "muddle." We purposely refrain from saying anything of the sort.

It will be seen from our parliamentary report, that the Metropolitan Board intend to oppose the Bill of the Chartered Company in the Lords. The dispute between the Board and the Company, however, is only concerned with a small patch of land adjoining the Beckton works, and is not of the smallest general interest. The parts of the Bill which most intimately concern shareholders and gas consumers are virtually passed, and time alone can reveal to which of the two parties they will be most advantageous. We abstain from expressing any opinion on the matter.

We regret extremely that we are not able, this week, to report the progress made in committee with the South Metropolitan Bill. In this case the opportunity is offered of reviewing a part of the legislation, which we are sorry to say has been accepted by a majority of the companies. It is understood that the company who originated the sliding scale decline to accept the auction clauses, except under compulsion. We cannot doubt that Mr. Livesey will be able to show Mr. Walter's committee as good reasons for the rejection of the auction clauses, as he did to Mr. Forster's committee last year, for the adoption of the sliding scale. We look to him for this protection of the interests of shareholders.

Apart from this, the only questions which can arise before the committee will relate to the amalgamation clause and the initial price. As regards the former, we cannot for a moment believe that the committee will raise any objection. The opposition of the South London local authorities on this point is simply absurd. A district, relatively small, like that of the South Metropolitan Company, cannot remain isolated from a general combination, and such is certain to take place. If it do not to-day, in the name of one company or another, it will certainly occur in the course of a few years, under an authority of some sort, central or municipal. Hence resistance, if successful, can only have a temporary value. A levelling up of price is certain to come, and the consumers of Camberwell may as well accept it at once.

With regard to the uniform initial price of 3s. 9d. per 1000 feet, we must regard that as definitively settled. We cannot imagine any arguments, that can be adduced by Camberwell and Lambeth, which will induce the present House of Commons Committee to override the decision of that of last year, and which has the express approval of a majority of the members of the Metropolitan Board to-day. It may be admitted that, in case of amalgamation, a rise of price in the district of the South Metropolitan Company would be inevitable; but some interests must give way for the general good. Narrow local views cannot be entertained. It is these which stand in the way of complete municipal government for the metropolis.

In the report of the Parliamentary Committee of the Metropolitan Board of Works, printed in another column, we have detailed the results of the conferences between the southern companies and the Board. We believe that a conference between the companies, the Metropolitan Board, and the Board of Trade, has since taken place, but the result we do not as yet know. It will be seen that we were substantially correct in the information we gave last week. The first desire of the southern companies is to obtain power to raise, on a simple certificate of the Board of Trade, new capital *pro rata*, or thereabouts, with the increase granted to the Chartered Company, if their Bill should pass. The notion is novel, and we are inclined to laugh; but we might let it pass, if the Surrey Consumers Company did not stand out. This company wish to raise new capital in a larger proportion; but why, we are unable to guess. It strikes us, however, as extremely odd, that any individual company, desirous of preserving an independent existence, should consent to raise capital in the same proportion as another company very differently circumstanced.

The power to acquire additional land by agreement, without the necessity of going to Parliament, we cannot regard as of much importance. If people agree, there can be no dispute; and if there be a dispute, Parliament is the only court of appeal. It is hardly possible to suppose a case in which objection would not be made to the acquisition of a site by a gas company, so ignorant and prejudiced are the public and local authorities, and we should prefer to go to Parliament at once, rather than to a Government Department, whose decision ought, in all cases, to be reviewed by Parliament.

It is not at all surprising that the Southern Companies should desire to be free from the dictation of the Referees. The Metropolitan Board, however, see the matter in a somewhat different light, and object to different legislation on the two sides of the river. Moreover, they appear to think the control exercised by the Referees beneficial. We shall express no opinion as to the value of the services of the Referees, and shall only now say that they are an expensive body. Still, we must be consistent, and here once again advocate amalgamation. One competent man could easily perform all the duties of the Referees and the Chief Examiner, and so effect a considerable saving in the costs of those institutions.

The desire of two of the Companies to have what may be called two years grace, during which they may make up their reserve-funds, is very natural, and, we may add, very reasonable. The proposal, if acceded to, would, no doubt, amount to the virtual suspension of the operation of the sliding scale for the next two years; but, considering the dark days that may come with the sliding scale, we think it only reasonable that the companies

should be allowed a brief period of sunshine, during which to make hay. The Metropolitan Board, however, object. A select committee may be more considerate.

It would appear that the Board are determined to push forward their Regulations Bill without waiting for the action of the Board of Trade. The whole question must, therefore, be re-opened before a Parliamentary Committee. A great opportunity is thus presented, of which we hope the companies will avail themselves. It seems to us by no means certain that the Metropolitan gas question will be settled this year.

We regret that we have not space this week for a very able report made to the Gas Committee of the Corporation of Leeds by their engineer, Mr. Henry Woodall. We do not say that the Corporation have failed in their duty, but we must remark that the question of extending the works, and overhauling the distributing plant, should have received their serious attention from the moment they came into possession of the undertakings. They have, however, pursued a sort of "hand-to-mouth" policy, and the result to-day is that the demand for gas in Leeds is 28 per cent. in excess of the means of producing and distributing it. The fault of this does not lie with Mr. Woodall, who has only recently been appointed Engineer. The present state of things has been brought about by the parsimony of the Corporation, who have sought, but failed, to make large profits on the undertakings. It is made perfectly clear, in the report we shall publish next week, that large additions to the works at New Wortley are imperatively required. Mr. Woodall states that 280 additional retorts will be necessary to supply the requirements of next winter. As regards a more distant future, we are inclined to think that Mr. Woodall under-estimates the wants of Leeds. If all should go well, a larger annual increase in consumption than five per cent. must be anticipated, and the truest economy would be found in making provision for the largest probable demands. It is quite clear that the distributing plant requires amendment, and the Gas Committee will do well to carry out immediately Mr. Woodall's suggestions.

The published accounts of the Corporation of Rochdale for 1875-76 show that their gas undertaking is in a prosperous condition. It is true that the profits of the past, were not so large as those of the previous year; but that is easily accounted for by the large reduction of price which was made at the beginning of the year. As we hold that Corporations ought not to make large profits on gas undertakings, we regard the accounts of that of Rochdale with much satisfaction.

The Vestry of Chelsea are exercised upon the question whether or not it is desirable to adopt the average meter system in the parish. Their able surveyor, Mr. Stayton, has written a report in which he seeks—as, indeed, the Imperial Company have sought—to prove, that any advantage the Vestries of Paddington and St. Pancras have gained, since the application of the system, has resulted from the employment of a smaller burner, and the adoption of reduced hours of consumption. We shall not contest the point. Our wish is to see the streets of the Metropolis well lighted—much better lighted, in fact, than they are at present; and, therefore, we deprecate the use of smaller burners. The hours of consumption may be curtailed in the summer months, and extended, with advantage, as occasion may require, in the winter. It is the inelastic contract system to which we object. We have never urged that any economy would result from the adoption of the average meter system, *per se*. We have advocated it, simply for the reason that it promised to satisfy local authorities that they had consumed the quantity of gas for which they were charged. Objections, such as have been made by the late Imperial Company, have, we rather think, never before been raised. If, however, the Referees be satisfied that unmetered lamps consume two-and-a-half per cent. more than the metered, by all means let the charge per lamp be arranged accordingly. We wait, with some curiosity, the report of the Referees on the question, after which we may, perhaps, indulge in further reflections on public lighting.

We can sincerely sympathize with Mr. Patterson, while upholding the judgment of the Court of Appeal, which has just deprived him of a patent right in the Lime Process of Purification, and loaded him with a heavy debt in the shape of costs. Having freely acknowledged the obligations which the gas companies owe to Mr. Patterson, we are the more at liberty to comment on the want of judgment he displayed in taking out a patent for a process which was clearly not patentable; and which, if it could have been made the subject of a patent, he was the last man who should have attempted to secure an exclusive right to it. The Lords Justices expressed themselves strongly on this latter point. The law gave the Referees the freest access to the companies works, and, indeed, a certain control over them. The companies, or, perhaps we ought to say the public, paid the original Referees—of whom Mr. Patterson was one—liberal salaries, found them an expensive office, furnished them with a well-fitted laboratory and paid the cost of a skilled chemical assistant. Under such circumstances, it might have been thought a matter of honour that any discovery—if such were made—should belong to the gas companies, or, rather, to the public. The Lords Justices, while not expressing any opinion as to the validity of a patent taken out by a gentleman for an alleged invention, made and discovered by him in the course of the performance of his public official duties, yet more than hinted the strong opinion they entertained upon the point. Our readers will remember that the first objection we took to Mr. Patterson's patent was on this very ground. In our issue for April 9, 1872, when noticing the Referees "Report on Sulphur Purification at Beckton," we wrote as follows:—"Taken in connexion with this report, we are "somewhat struck by the fact that the patent list we "published in our last, announces that a patent has "been applied for by Mr. Robert Hogarth Patterson "(presumably the Gas Referee of that name), for 'Im-"provements in the Purification of Coal Gas?' We shall "have to wait for six months to know in what the improvements "consist; but can it be possible that they have any relation to "the subject treated of in this report? Would it be, say, "reasonable to patent discoveries arrived at in the course of "experiments conducted at the expense of the gas companies?" It turned out that it was a fact, that the process briefly indicated in the report had been made the subject of a patent. But what, when the patent was published, became of the alleged discovery? It was clearly seen that no discovery at all had been made. The chemical facts set forth were as old as the hills, and the first claim made by the patentee had been anticipated by Mr. Mann, who had previously patented the use of sulphide of calcium in separate purifiers. There was, in fact, an absolute want of novelty, so far as invention was concerned. Mr. Patterson explained, but he did not invent. He gave, as Lord Justice James put it, "valuable working cautions and directions," and that was all. Nevertheless, we shall repeat here an opinion published in our issue for Oct. 7, 1873, that "the gas world is somewhat "indebted to Mr. Patterson. His habits of thought as a politi-"cal economist, rather than his knowledge as a chemist, helped "him to a right understanding of the apparently complicated, but "really simple process of gas purification; and if his deductive "method only led him to the discovery of known facts, we are "bound to say that his reasoning upon those facts placed him "far in advance of most gas managers. His mistake was in "patenting his discoveries. If, instead of rushing to the Patent "Office, he had attended the earliest meeting of the British "Association of Gas Managers, and there expounded his views "on Purification, he would have gained immense *kudos*, and for "profit, he would certainly have been a Gas Referee to this "day, while his patent, we expect, will never produce him a "farthing." This last remark looks prophetic, but we are here reminded that we may not have heard the last of the case. An appeal may be made to the Judicial Committee of the House of Lords, and we feel bound to refrain from further observations. What we have said will not, we hope, excite the sensibilities of Mr. Patterson's solicitors. We repeat that we sincerely sympathize with Mr. Patterson, who, as matters stand at present, from a simple error of judgment, is a sufferer to the extent of some £12,000. He has now to decide whether an appeal to the Judicial Committee of the House of Lords is likely to clear away or add to his liabilities.

Our very talented, but, it must be admitted, somewhat eccentric friend, Mr. Lewis Thompson, has, we find,* written to the Board of Trade, and to the Premier, offering to take the office of Chief Gas Examiner, and to repay his salary into the public Exchequer. His reasons for taking this step, and the advantages which he expected to accrue if he obtained the post, the duties of which he is willing to discharge *gratis*, will be found set forth in the pamphlet from which we quote. There is, perhaps, no man living more competent to fill the office than Mr. Lewis Thompson, but it is quite clear that no Government department could accept of gratuitous services. What would be the value of patronage if such an example were set?

We commence to-day a report of the very interesting trial of *Sugg v. Silber*. As that report does not come down to the conclusion of the case, we may announce here that the verdict of the jury was for the plaintiff on all points. It will be remembered, to Mr. Sugg's honour, that he endeavoured to have the case tried before experts, or, at all events, an expert judge. The defendant, however, preferred that it should be decided by an ordinary special jury. We are at present uncertain whether or not litigation has ended, and therefore must refrain from expressing any opinion on the merits of the case.

* See "Remarks on the Purification of Water and Other Things," by Lewis Thompson, M.R.C.S., &c. Sandy, Bedfordshire, May, 1876.

Water and Sanitary Notes.

If we had space, and deemed it useful to devote that space to a further review of the recent Conference on the Health and Sewage of Towns, at the Society of Arts, ample matter for comment is at hand. We must, however, refrain; and recommend all sanitary authorities to wait and look for more authoritative guidance, in the coming report of the Local Government Board, than is to be found in the confused and somewhat contradictory utterances at the meeting in the Adelphi. It may, however, be distinctly admitted that no method of treating sewage has hitherto been profitable in a pecuniary sense. For the present, at all events, we have to pay to be quit of a nuisance, and the question which presses on local authorities to-day is, how the sewage can be most cheaply disposed of. In the case of a town on the banks of a river of any considerable size, no doubt a precipitation process can be successfully applied. In the case of districts, however, which do not possess the advantage of contiguity to a large river, another system of purification must be found, and that, we believe, exists in the intermittent downward filtration plan of Mr. Bailey Denton. There may, however, be cases in which the two systems may be usefully combined.

The "Health of Towns, in connexion with the Methods of the Disposal of Sewage," was, we think, very inadequately treated at the Conference. Some opinions were expressed that the water-carriage system was responsible, if not for the introduction, at all events for the spread of typhoid fever in our towns. This matter should have been sifted to the very bottom. All the time of the Conference might have been profitably spent on this one question. It was, however, passed over very cursorily on this occasion. As the Conferences are to be held annually, we hope the subject we mention will receive more attention at the next, and that the speakers will come prepared with more information than speculation.

The accounts of the Sanitary Manure Department of the Corporation of Rochdale have by no means an unsatisfactory look, except in one particular—the Corporation do not appear to be sufficiently energetic in the collection of their accounts. We notice that, on March 31, 1875, there was owing for manure £4208, and that in the course of the year ending March 31, 1876, only £2426 had been paid, and that there is now owing £2915. The value of the manure seems also to have depreciated, for whereas that in stock in 1875 was valued at £6240, the stock in hand this year is considered worth only £2877. For our own parts, we are strongly in favour of the Rochdale system, which certainly does not encourage typhoid fever. We should, further, like to be assured, that if not actually profitable, it involves no great loss.

While speaking of Rochdale, we may mention that the water accounts of the Corporation show that the circumstances of the undertaking are improving. The revenue accounts show a small balance of profit for the past year, and we do not suppose a rate-in-aid will be necessary this year.

The decision of the Commons Committee on the Stockton and Middlesbrough Water Bills is exciting a good deal of attention in the two towns, and we are inclined to think that there is a general wish that the Bill of the Corporations may be rejected by the Lords Committee. But for the fact that we always, upon principle, support private as against Corporation enterprise, we should at once recommend the company to withdraw from all opposition, and, trusting to the result of arbitration, leave the Corporations in possession of their white elephant. The Corporations are placed in a serious "fix" by the decision of the Commons Committee, and it is now the duty of the company to insist that the terms imposed shall be rigidly carried out, or the Bill abandoned.

Testimonial to the ex-Governor of The Gaslight and Coke Company.—Last week the directors, past and present, of The Gaslight and Coke Company entertained at luncheon the late Governor, Simon Adams Beck, Esq., on which occasion they presented him, on their own behalf, with a testimonial, consisting of a pair of handsome and massive silver tazzas, as a token of their appreciation of his high character and worth, and of their personal regard for him as a colleague with whom they had cordially laboured in carrying on the vast operations of the company. The committee of shareholders (consisting of Mr. Yool, Mr. Rokeby Price, Lieut.-General Sir Edward Hodge, K.C.B., Mr. Baddeley, and the secretary, Mr. Phillips), which was recently formed to receive subscriptions from the general body, for the purpose of presenting a shareholders testimonial to the respected governor on his retirement, after 28 years connexion with the board, have already received nearly £700 towards the desired object, and the subscription list is not yet closed.

Transfer of the Maryport Town and Harbour Gas Company's Works.—The award of Mr. Hunt, the umpire appointed in the arbitration between the Trustees for the Town and Harbour of Maryport and the Maryport Town and Harbour Gas Company, relative to the purchase of the works of the latter, was received in Maryport on Saturday last. It fixes the price to be paid for the works by the trustees at £15,701 17s. 8d., which is equivalent to about £16 per share. The trustees have also to pay the costs of the award, amounting to £542 3s. 7d., and are to take possession and pay for the works on the 30th of June next. If they fail to do this, they will have to pay interest at the rate of 4½ per cent. on the amount of the purchase-money.—*Carlisle Journal.*

Correspondence.

THE ALLEGED NUISANCE AT THE EXETER GAS-WORKS.

Sir,—I have only just seen your articles of the 2nd and 9th inst., and Mr. Standfield's letter which appears in your number of the 9th inst., and I hope that, in fairness, you will allow me to put the real facts of the case before the public, through your columns, as I think I can prove that though the case broke down before the magistrates, the stink *did* come from the gas-works, and that the failure to convict the gas company occurred simply from the careless way in which the Town Council had got up their case, and through their not having the works thoroughly inspected on their behalf by a good gas engineer.

I am certainly not going to defend the Town Council, but I must say that your remarks about their desire to depreciate the value of the gas-works by persecuting the company are very wide of the mark, for the fault that we have had to find with them is their want of energy in not prosecuting the company long ago, and the late proceedings were instituted on the complaint of myself and other householders to the Town Council, as urban sanitary authority. We had pressed the Town Council for years to prosecute, and the proceedings now were taken under the Act of 1875, which leaves them no alternative, but compels them to proceed on complaint being made.

Before proceeding further, I should like to say that so far from wishing to find any fault with the directors of the gas company, I am glad to have this opportunity of publicly thanking them, and especially their chairman, for the kindness that has been shown to me in the investigation of this matter. The moment that they found that their works were a cause of nuisance to the neighbourhood (which I think they will now admit was the case), they showed an earnest desire to ascertain from what cause the nuisance proceeded, and a readiness to adopt any suggestion which I had thrown out to mitigate or remove it. Had their servants been equally desirous to prevent the works being an annoyance to the neighbourhood, I doubt whether the nuisance would ever have occurred, but the company have throughout been badly advised in the construction of their works, and badly served in the management of them.

As some of your readers may have forgotten the case, I will now state shortly what the real facts are. The inhabitants of Exeter have for years been annoyed or poisoned by a most lothsome smell, which appeared to come from the gas-works, or their immediate vicinity. Some of the best houses in the city are situated on a cliff overhanging the river, not more than 400 yards from the gas-works, and almost on a level with the highest chimney there, thus being liable to be affected by effluvia which they would otherwise escape. Until about three years ago the ammoniacal liquor from these works was converted into manure, in a manufactory adjoining the gas-works. At the urgent request of some of the inhabitants, the gas company got this manufactory removed to a distance, and it was hoped that the stink was done away with; but though it decreased greatly after the removal of these works, it still continued, and about six months ago it became as bad as ever. As the inhabitants were then convinced that it came from the premises of the gas company, the present prosecution was commenced.

The Town Council of Exeter, who were the prosecutors, did not bring any scientific evidence whatever; they trusted entirely to the common-sense argument that there was a stench (which nobody denied), that it never came except when the wind blew from the gas-works, and that it was invariably accompanied by a peculiar vapour from a particular chimney—viz., the chimney of the engine-house, in fact. Except myself and one other person, they had no evidence whatever from witnesses who had traced the stink to a point *inside* the gas-works. The defence, of course, took the usual line of bringing an array of other stinks, which they maintained might, individually or collectively, cause the nuisance complained of. Sewers, glue, hides, asphalte, and the river were successively paraded by the ingenious counsel for the defence, but although his speech, and your leading article, would lead people to suppose that Exeter was a most stinking place, I think I need only state that though living in the part of the city most exposed to the array of stinks enumerated, I have never been annoyed by any one of them; perhaps the most conclusive evidence of which will be, that *since* the gas company have made certain repairs, to which I shall call attention hereafter, we have not been annoyed by any stink, whereas before, hardly a day passed without it.

The real cause why the prosecution broke down was—

1. Because the company proved conclusively that no noxious vapour could come out of the engine-house chimney, and

2. Because the prosecution had no scientific evidence to put against the overwhelming proof brought by the company, to show that their works were managed in the most perfect manner.

Nearly the whole of the staff of the gas-works were brought forward to swear that they had never smelt a stink there in their lives; and, in addition to that, Mr. Keates, a most eminent gas engineer from London, and other scientific witnesses, were brought forward to swear that the works had been examined by them, that they were in perfect order, were conducted with all modern improvements, and that no effluvia could possibly escape from any part of them in sufficient quantity to create a nuisance. What I am about to tell you will, I think, show that, had these gentlemen used a little more care in their inspection of the works, and not taken for granted all they were told by the servants of the company as to the perfect order in which everything in the works was, they would not have been quite so ready to swear what they did.

The next morning, after the trial, Mr. Buckwell, the counsel for the prosecution, went down to see the gas-works. He first went into the asphalte company's yard, and, standing on the heap of stuff referred to in my evidence, as the point from which I had smelt the stink, when he looked over the wall the stink was so bad that his companion was taken extremely ill.

Mr. Buckwell then sent for the town-clerk, who came and inspected the works, accompanied by a manufacturing chemist who understood gas-making. What they then discovered was sufficient to prove, with the aid of what I myself afterwards found out, that there was a large escape of sulphuretted hydrogen, or some equally noxious gas, such as hydrosulphate of ammonia, from the large tar and liquor tank, which lies under the greater part of the ground adjoining that wall. The pump in the corner, which forces the liquor up the scrubbers, allowed this gas to escape, so did the tar-pump (which has since been taken to pieces, and found to be in a most defective condition), and there was another large

leak close to the scrubbers, where the suction-pipe for liquor enters the tank. In fact, the whole of the fittings of the tank were in a most dilapidated condition.

In addition to this, it was found that the tanks of ammoniacal liquor above the scrubbers were covered with only wooden boards, that one of these covers (viz., the one nearest the asphalte yard) had a corner broken off, exposing at least two superficial feet of the liquid; the remainder of this cover was also so old and rotten that the liquor was bubbling through each bolt-hole when the broken corner was replaced. The escape of sulphuretted hydrogen was so considerable as to *nearly blacken* test-paper (acetate of lead) held at arm's length from the scrubbers, and not, as Mr. Standfield's letter would lead you to suppose, placed close to the hole in question. The value of this gentleman's testimony will, I think, be evident when I refer you to what he swore the day before. His words then were: "The ammoniacal liquor was always contained in air-tight compartments, from the time it was first produced to when it was sent away." As these tanks contain a large quantity of ammoniacal liquor, the most charitable supposition is that he had never seen their condition, in which case he had evidently grossly neglected his duty as manager.

I would here mention that the sulphuretted hydrogen, escaping at this point, did not, in my opinion, come from the mere presence of the ammoniacal liquor in an uncovered tank, but because there was a fresh supply of this stinking liquid being constantly pumped up from the large tank below.

The air inside the large tank must be perfectly saturated with sulphuretted hydrogen; it is being kept in a constant state of agitation by the liquor being pumped again and again up the scrubbers, and fresh liquor and tar are also constantly pouring into the tank, displacing, as they do so, a proportionate quantity of this foul air, which found a vent at the leaks that I have described.

When standing in front of the scrubbers, I have found that this leakage was so considerable that I could distinctly trace foul gas escaping at each stroke of the liquor-pump, and as the engine drives this pump, I think this fully accounts for the smoke from the chimney being thought the cause of the stink; moreover, the chimney is in a line with, and nearly the same height as, the scrubbers.

This leakage of sulphuretted hydrogen of course varied according to the tank being full or empty, and it is very probable that when the scientific witnesses paid their visit to the works it was nearly empty, and there would then have been no smell, but how the manager can have been ignorant of it I am at a loss to conceive.

The gas company have done their best to remedy these leaks, and are also thoroughly overhauling the scrubbers; but, as I have pointed out to them, the pressure on the air in the large tank is so great that if the tank is filled rather more than usual, the air will find a vent somewhere, and the nuisance will be renewed.

The remedy for this appears to me to be either to ventilate the tank through a pipe into the furnace, or through some substance such as oxide of iron or charcoal, which will render the sulphuretted hydrogen harmless. The latter plan, I believe, they have under consideration.

I have also pointed out to them that, at the gas-works that supply Brighton, they "scrub" the gas with pure water, and that if this could be done here it would greatly tend to prevent the possibility of a renewal of the nuisance. I should be glad to know through your columns whether this could be done without deteriorating the quality of the ammoniacal liquor produced.

In conclusion, I think I have shown that the management of these gas-works was very far from being as perfect as the evidence tendered the other day led you to suppose.

That the stench complained of came from there, is beyond a doubt; but I hope that, if the gas company carry out the reforms they are now proposing, we shall hear no more of it, and Exeter will at last be able to present a free bill of health.

The great difficulty lies with the gas company's officials, for, from what I have seen of the works, they seem to be utterly ignorant of the fact that a great many small stinks may make one big one.

C. Halford Thompson,
Captain (Half-pay), Royal Artillery.

9, *Colleton Crescent, Exeter, May* 15, 1876.

MALAM'S PROCESS OF GAS-MAKING.

Sir,—Twelve months ago I was drawn into some correspondence on "Malam's Patent Process," and I am reluctantly drawn into it again, owing to the remarks made by Mr. Dunlop, the President of the West of Scotland Association of Gas Managers, in his admirable inaugural address, published in the Journal of the 16th inst. In the course of his observations on Malam's process, he administers a severe castigation to some one; and although he does not mention names, he might as well have mentioned mine, as I believe I am the only one who, having adopted it, ventured to say anything about it—at least I feel the "cap fits me," and I hasten to relieve myself of the awful responsibilities I have unwittingly been lying under, as enumerated in that dreadful paragraph which I cannot bring myself to quote, but which commences thus: "But if their gains are so wonderfully great," and ends with, "and so free themselves from the criticisms which they have so justly incurred."

I can only say, in extenuation of my silence, that, had I but known of the tremendous "agitation," and the frightful "suspense" I have "caused in their minds," I would certainly have trespassed upon your space ere this; but, believing that my former remarks about the process had been sufficient, I had no intention of saying more. I am, however, compelled by the words of that agonizing paragraph to speak once more, and at once, having not the slightest intention of "betraying a trust to the patentee, the gas world, or the members of the West of Scotland Association of Gas Managers," and being at all times ready to communicate anything for the good of the gas world.

Mr. Dunlop takes a very strange method of asking for information by condemning the process as an impossibility, as he says, "In his opinion it is impossible to conceive an increase of heat of the retort, thereby increasing the yield, without correspondingly reducing the illuminating power;" and then, a little further on, in describing some of his own very interesting experiments, he gives, at paragraph C, the solution of what appears to him a paradox, and which he has just found out, but a fact which has been known for years, and hence the reason why exhausters have of late been fixed after the condensers and scrubbers, instead of before them, as they used to be. He does not appear to be aware that, owing to this change is greatly to be attributed, the increase which has taken place in the illuminating power of the gas made from Newcastle coal. When I put up Mr. Malam's principle of retorts, I did not agree with his condensing and exhausting arrangement, as I was somewhat of the same opinion as Mr. Dunlop; so I altered my apparatus, and put up a form of condenser that increased the illuminating power, while I got an increased yield by the high heats. And I shall be very glad to show Mr. Dunlop, or any one interested, at my works, how to get 12,000 cubic feet of gas of 14½ candles from one ton of Newcastle coal by the Malam process.

John Somerville.

20, *Westland Row, Dublin.*

P.S.—I believe that at Dumfries, unless the condensing and exhausting arrangement has been altered, a decrease in the illuminating power must necessarily result from the high heats.

SIMULTANEOUS LIGHTING OF PUBLIC LAMPS.

Sir,—In your Journal of May 16, I see that Mr. W. Smith read a paper on the above subject before the West of Scotland Association of Gas Managers. Allow me to state that, for several months past, I have been using a similar burner to the one illustrated by Mr. Smith—first in the town of Alford, in Lincolnshire, and now at Huddersfield. At Huddersfield, however, we have only seven public lamps, near the gas-works, fitted with these burners; and it is questionable whether a decided opinion can be given as to the practical working of the system until a whole town is lighted by it, and it has been many months in operation. Mr. Livesey, of the South Metropolitan, has tested, or has now in use, a few of the same burners. Mr. G. W. Stevenson, C.E., of Westminster, has also inspected those in use at Huddersfield, but has not yet given his report upon them. The invention is a German one; but I have not heard that any town in Germany has it now in use, though I believe it has been tried in Heidelberg. So soon as I can write more definitely on the subject, I will send you fuller information.

W. Cartright Holmes.

Whitestone Iron-Works, Huddersfield, May 20, 1876.

Parliamentary Intelligence.

HOUSE OF LORDS.

Monday, May 15.

The Lord Chancellor acquainted the House that the further Standing Orders applicable to the Redcar and Coatham Gas Bill have been complied with, and that no further Standing Orders are applicable to the York New Water Bill.

The Blackrod Local Board Bill was reported from the select committee, with amendments.

An amendment was reported to the Gas and Water Orders Confirmation Bill.

The Local Government Provisioinal Order, Skelmersdale (No. 5), Bill, brought from the Commons, was read the first time, and referred to the Examiners.

Tuesday, May 16.

The Slaithwaite Gas Bill, brought from the Commons, was read the first time, and referred to the Examiners.

The Rossendale Union Gas Bill was read the third time, with the amendments, and passed.

The Gas and Water Orders Confirmation Bill was read the third time, and passed.

Thursday, May 18.

The Redcar and Coatham Gas and York New Water Bills were read a second time, and committed.

The Llandudno Improvement Bill was referred to a select committee, consisting of Lord Methuen (chairman), Lord Saltersford, Lord Bolton, Lord Sandhurst, and Lord Harlech; to meet on Tuesday, May 23.

The Stafford Borough Extension, Walsall Gas Purchase and Borough Extension, and Gas and Water Orders Confirmation (Chapel-en-le-Frith, &c.) Bills, were referred to a select committee, consisting of Earl Devon (chairman), Lord Inchiquin, Lord Ventry, Lord Carysfort, and Lord Oxenfoord; to meet on Tuesday, May 23.

Friday, May 19.

The Lord Speaker acquainted the House that the Standing Order applicable to the Local Government Provisional Order, Skelmersdale (No. 5), Bill, has been complied with.

The Blackrod Local Board Bill was read the third time, and passed.

The following bills, brought from the Commons, were read the first time, and referred to the Examiners:—Kildwick Parish Gas, South Hants Water, Stockton and Middlesbrough Corporations Water, Whitehaven Town and Harbour Improvement.

The Maidenhead District Gas Bill was returned from the Commons, agreed to, with amendments, which were considered and agreed to.

HOUSE OF COMMONS.

Monday, May 15.

The Lancaster Water and Improvement Bill was reported.

The Slaithwaite Gas Bill was read the third time, and passed.

The Kildwick Parish Gas and Stockton and Middlesbrough Corporations Water Bills, as amended, were considered; amendments made; bills to be read the third time.

The Maidenhead District Gas Bill (Lords), as amended, was considered; bill to be read the third time.

The Whitehaven Town and Harbour Improvement Bill, as amended, was considered; clause added; amendments made; bill to be read the third time.

On the motion of Sir Charles Forster, it was ordered—"That the minutes of evidence taken before the committee on the Wakefield Water Bill, in session 1874, be referred to the committee on the Wakefield Water Bill."

Examiners report presented, that the Standing Orders have been complied with in respect to the petition for additional provision in the Horncastle Gas Bill. Instruction to the committee on the bill that they have power to make provision therein accordingly.

The petition of Consumers of gas within the district against the Colney Hatch Gas Bill was withdrawn.

Tuesday, May 16.

The South Hants Water Bill was read the third time, and passed.

The Edinburgh and District Water (Lords) and Tunbridge Wells Gas Bills, as amended, were considered; bills to be read the third time.

The following bills were reported:—Dunfermline Water, Oldbury Local Board of Health, Smethwick Local Board, Halifax Water and Gas Extension.

A petition against alterations in the Leigh and Hindley Local Boards Bill (Lords) was presented from Richard Henry Ainsworth.

Wednesday, May 17.

The Huddersfield Water and Improvement Bill, as amended, was considered; to be read the third time.

The Paisley Water Bill, as amended, was considered; amendment made; bill to be read the third time.

The Leigh and Hindley Local Boards Bill (Lords) was read a second time, and committed.

THURSDAY, MAY 18.

The following bills were read the third time, and passed:—Kildwick Parish Gas, Maidenhead District Gas (Lords), Stockton and Middlesbrough Corporations Water, Whitehaven Town and Harbour Improvement.

The Newcastle and Gateshead Water and The Gaslight and Coke Company Bills were reported.

The Gas and Water Orders Confirmation Bill (Lords) was read the first time.

A petition against the Burghs (Scotland) Gas Supply Bill was presented from Borrowstounness.

The petitions of (1) the Uppingham Rural Sanitary Authority, and (2) the Marquis of Exeter and other landowners, against the Uppingham Water Bill, were withdrawn.

BURGHS (SCOTLAND) GAS SUPPLY BILL.

Sir WINDHAM ANSTRUTHER moved that this bill, which stood for recommittal, should be referred back to the select committee which had just sat upon it, in order to reconsider some of the clauses which they had introduced into it.

Mr. CECIL RAIKES said he would not oppose the motion, but he should have resisted a proposal to adopt the bill as it now stood. Some of the changes which had been made in it were of a most important character, and if it had been intended to adhere to them he should have felt it necessary to explain, at some length, the reasons why he thought the bill ought to be rejected altogether.

Sir E. COLEBROOKE complained that the honourable member for Chester had not stated what the radical changes were to which he objected. Without suggesting that the committee were infallible, he hoped they would not be deterred, in reconsidering the measure, by the threat which the honourable gentleman had held out.

The motion was then agreed to.

[In consequence of the length of our "Legal Intelligence," we are obliged to postpone our Parliamentary Committees reports till the next number.]

Legal Intelligence.

SUPREME COURT OF JUDICATURE.
HIGH COURT OF APPEAL—CHANCERY DIVISION.

LINCOLN'S INN, MONDAY, MAY 8, TO TUESDAY, MAY 16.

(*Before Lord Justice* JAMES, *Lord Justice* BAGGALLAY, *and Justice* LUSH.)

PATTERSON *v.* THE GASLIGHT AND COKE COMPANY.

This was an appeal from a decision of Vice-Chancellor Bacon. The bill was filed by the plaintiff to restrain an infringement of his patent, dated the 9th of March, 1872, for "Improvements in the Purification of Coal Gas." Mr. SOUTHGATE, Q.C.; Sir H. JAMES, Q.C.; Mr. DAVEY, Q.C.; and Mr. STERLING (instructed by Messrs. Curtis and Bedford, of Haberdashers Hall, Gresham Street), appeared for the appellants, the gas company; Mr. KAY, Q C; Mr. FRY, Q.C.; Mr. ASTON, Q.C.; and Mr. TREMLETT, Q.C., appeared for the respondent, the plaintiff. The case was heard before the Vice-Chancellor in December and January last, and on the 1st of February his lordship gave judgment, overruling all the defences of the company as to want of novelty in the plaintiff's patent; anticipation by a patent of Mr. W. Mann; prior user; and the disqualification of the plaintiff, as a public officer, to be the patentee of an invention or discovery which had come to his knowledge in his official capacity. His lordship granted an injunction against the company, with an inquiry as to damages and costs of suit, but suspended the injunction for three months, to enable the defendants to appeal if so advised, they undertaking to pay such damages as the court should award in respect of such suspension, should the injunction be maintained. Against this decision the defendants now appealed.

Mr. SOUTHGATE, in opening the case, said the suit was undoubtedly one of the greatest importance to both parties. If the plaintiff was right, he would be entitled to dictate his own terms to gas companies for the future, during the existence of his patent, as to the royalties they should pay him, for the gas purified by them. On the other hand, the companies would be unable, as he understood the matter, to know how to carry on their operations, even in the mode which they had been pursuing for years, without being said to infringe the plaintiff's patent. In order that their lordships might understand the questions arising in this case, it would be as well for him just to state that which his learned friend, Mr. Kay, stated in the court below, as to the nature of the plaintiff's invention. He could not do this better than by using Mr. Kay's own words. His learned friend commenced by informing the court that this was a patent for improvements in the mode of purifying coal gas, and he went on to state that there were certain forms of matter in crude coal gas which were called impurities, they being six in number—namely, tar; aqueous vapour, or water; ammonia; sulphuretted hydrogen; sulphur in other forms, the principal of which was sulphide of carbon, but it was referred to continually as sulphur in other forms, in the evidence; and the last was carbonic acid. The first three were very easy to get rid of—namely, the tar, the water, and the ammonia. The tar and water were got rid of by cooling and condensing the gas, and washing it with water in vessels which were called condensers; and, for the purpose of the suit, his lordship might dismiss from his mind any further consideration of the two ingredients tar and water. Ammonia also was very easily got rid of. It could be got rid of, because it mixed readily with water; and although ammonia occurred in part of the patent and part of the evidence which he should have to refer to, he should not have to trouble the court very much with it. Sulphuretted hydrogen existed in gas in considerable quantities, and there had been a long and well-known mode of getting rid of that. The ordinary mode was by treating the gas with oxide of iron, which readily absorbed sulphuretted hydrogen, and separated it from the gas. He (Mr. Southgate) might mention as a fact, which would be useful in explaining certain parts of the evidence, that the use of oxide of iron for this purpose was discovered in 1850. Previous to that time, he believed all purification of gas was effected solely by means of lime, but by subsequent legislation, to which he would call attention, the use of lime could not take place in urban gas-works, and it had to be done by means of the oxide of iron. In the works, to which the present suit had special reference—namely, the enormous works of The Gaslight and Coke Company at Beckton, near North Woolwich, and also the Bow Common works belonging to the same company, which they acquired in 1870—inasmuch as they were suburban works, the use of lime was still adopted. His learned friend, Mr. Kay, went on to inform the court below, that the purification of gas from sulphuretted hydrogen was effected by passing it through purifiers which contained trays of oxide of iron, which absorbed the sulphuretted hydrogen. But the difficulty which the plaintiff's patent, for the first time, surmounted was to get rid of the sulphur in other forms than sulphuretted hydrogen. All the best heads of the great chemists and gas engineers had been long at work on the problem how to get rid of the compounds of sulphur, other than sulphuretted hydrogen, which existed in gas, and until the patent was taken out that difficulty was never solved. In this last sentence he (Mr. Southgate) did not entirely concur, but he read it as a fair statement of the point made by the plaintiff. The original bill in this cause alleged, in the usual way, that the plaintiff was the first inventor, that the letters patent were dated March 9, 1872, and that the complete specification was not filed until Sept. 9, 1872. Without, at the present moment, calling attention to the details of that specification, he would refer to the five claims which were the subject of the patent. And he might say, once for all, that the plaintiff had made, in the view of lawyers, the mistake which a great many inventors made—viz., having got, as he thought, two or three good ideas, or five in reality, he had put all five into one patent. Of course, if any one of these five was bad, there was an end of the patent, and as to some of them, he did not know what could be said for them. His learned friends got rid of them in a most ingenious manner in the court below. The discussion turned very much on the first and second heads, but he was bound to say that in his view three, four, and five were about as hopelessly bad as any things could possibly be, and yet he did not see that the plaintiff dealt with them at all. The plaintiff was his own principal witness, and he told their lordships, upon oath, notwithstanding all the evidence on the other side, that the defendants had no case at all; but as to that their lordships would be the judges. The defendants witnesses included Mr. F. J. Evans—who had been the engineer-in-chief of their company for many years, and was now one of the directors—of whom his learned friend spoke as one of the first gas engineers in the world; Mr. Trewby, the manager of the Beckton works; Mr. R. Harris, the manager of the Bow Common works; the late Dr. Letheby, Dr. Odling, Professor Wanklyn, Mr. Keates, Mr. Kirkham (the engineer of the Imperial Gas-Works), and Mr. R. P. Spice, all of whom stated facts to show that what the plaintiff supposed he had discovered was known long before the date of his patent. This evidence the plaintiff endeavoured to dispose of by making out, from documents, from letters, from conversations, from a line here and a line there, that it could not be true. The five claims which the plaintiff made were these—

1. The employment of sulphide of calcium, in separate purifiers, as a means of purifying coal gas from sulphur existing in other forms than that of sulphuretted hydrogen.

2. A method or system of employing lime purifiers, in the manner hereinbefore described, whereby the contents of all the said purifiers, or of any required number of them, can be converted into sulphide of calcium, and also (if required) be maintained in that condition.

3. The employment of a solution of caustic soda, or of potash, or of ammonia, used in washers or scrubbers, in the manner hereinbefore described, in order to eliminate carbonic acid from coal gas, and in such a manner as to convert the lime in the purifiers or the soda solution contained in any required number of the said washers or scrubbers into sulphide of calcium and sulphide of sodium respectively, and also, if required, to maintain them in that condition.

4. The employment of the soda washers or scrubbers, after the gas has been purified from carbonic acid and sulphuretted hydrogen, as a means of purifying the gas from sulphur existing in other forms than that of sulphuretted hydrogen.

5. The employment of sulphur in a fine state of division in conjunction with an inert substance, suitable to form a porous material through which the gas may pass freely, or in combination with lime or with soda (or with lime and soda together) in solution or otherwise, in order to effect the purification of coal gas from sulphur existing therein in other forms than that of sulphuretted hydrogen.

The objections taken by the defendants to the original bill were several. In the first place, they stated that the plaintiff was not the first inventor, and then they denied the novelty. They then stated that the plaintiff, on Sept. 1, 1868, was appointed by the Board of Trade one of the three gas referees under the City of London Gas Act, and continued to hold that office until he was superseded in the month of September, 1872. The Act just mentioned enacted that the referees should, with all practicable speed, after their appointment, and should also from time to time thereafter inspect the works of the companies, and investigate the processes of manufacture carried on by them, with the view of ascertaining the means adopted by them for purifying gas and preventing nuisance in the operation, and might, from time to time, also apply such tests as they thought expedient at the works or elsewhere for ascertaining the amount of sulphur and ammonia, and of compounds thereof, or other impurity with which the gas supplied by them was charged. Section 35 required the companies to give to the referees every facility for the execution of their duty. The defendants stated that they believed that previously to his appointment as a gas referee the plaintiff had no acquaintance with the modes and processes of manufacturing and purifying gas; that Mr. F. J. Evans, their chief engineer, who was also originally appointed a gas referee, explained to his colleagues the processes employed, and procured for them, as well as for the chemist appointed by the referees—Mr. Thompson—opportunities from time to time of inspecting such processes in their practical application at the different gas-works in London, and more particularly at the various works belonging to the defendants. They also stated that their engineers and officers made the plaintiff acquainted from time to time with the results of experiments undertaken by them for the purpose, amongst other things, of purifying crude gas from sulphur compounds. They further stated that they believed, and had no manner of doubt, that the plaintiff derived his knowledge of the mode which he pretended to invent, from opportunities afforded to him, in his official position, as to processes employed by the company, and from information supplied to him by persons employed by the company. They also submitted to the court whether it was competent for the plaintiff to make use of the knowledge acquired by him as a public officer in discharge of his duty for the purpose of taking out a patent.

Lord Justice JAMES: That hardly arises in this suit, does it?

Mr. SOUTHGATE said the defendants further alleged as a fact that, previous to the date of the plaintiff's patent, the subject of the purification of coal gas from sulphur existing in other forms than sulphuretted hydrogen, had for a period of 20 years engaged the attention of gas companies and their engineers and consulting chemists, and one of the principal duties of the referees was to fix a maximum amount of such impurity with which the gas supplied by the companies, subject to the Act of 1868, might be allowed to be charged. They denied that no successful result in the removal of this impurity had been effected before the plaintiff's patent, and they proceeded to set forth in their answer, by whom and in what manner the efficient purification of coal gas from sulphur compounds had been previously accomplished. The learned counsel then referred at length to the evidence of the defendants as to what was done at Beckton in this direction prior to the date of the defendants patent, the details of which were given in our report of this case in the Vice-Chancellor's Court. He then passed to a description of the process of purification at the Bow Common works, and which has been substantially in use from the month of November, 1867, to the present time—a process which all the scientific witnesses called for the defendants swore was an anticipation of the plaintiff's patent. It was a very remarkable thing, he said, that, although the plaintiff was his own chief witness, yet he produced several witnesses, not one of whom seemed to know what had been done at Bow, and never said a word about it. The defendants, moreover, stated that, until the institution of the present suit, the plaintiff never attempted to put his letters patent in force, and this was one of the difficulties attending the case. The defendants had no means of doing what was often to be done in patent cases—viz., take their witnesses to see what the plaintiff was actually doing. His patent was a mere paper patent, and, unfortunately, the company had not adopted a plan adopted at common law, under which they could have got the particulars from the plaintiff in what way he alleged they were infringing his patent.

Lord Justice JAMES: I suppose his case will be this: "I have taken out a patent, you use it, and your use of it is a proof of the goodness of it."

Mr. SOUTHGATE said that was the plaintiff's case, and the only remark he

had to make was that the defendants could not, as in ordinary cases, see what the plaintiff was doing, so as to judge of the alleged infringement. The argument of the defendants in the court below was this, that there was no novelty, at the date of his patent, in the employment of sulphide of calcium in separate purifiers, which was the first head of the plaintiff's claim, and the plaintiff had described no new method for the application of sulphide of calcium to that purpose. Independently of the want of novelty, they insisted that the second head of invention was not the proper subject of a patent.

Lord Justice BAGGALLAY: I gather from what you have said that you rather rely upon the process carried on at Bow to prove anticipation of the plaintiff's patent.

Mr. SOUTHGATE said most certainly, if the defendants evidence was to be believed, the process at Bow was an anticipation, and in opening the case he admitted that he went more upon that than upon anything else. But apart from that, if the operations at Bow were struck out altogether, he believed that he should be able to prove anticipation at Beckton—*i.e.*, that what the plaintiff had done was merely a new way of using old tools. Mr. Trewby, in the course of getting his enormous establishment to work, had himself tried the very experiments which, on a smaller scale, the plaintiff probably tried. Moreover, before the date of the patent, Mr. Trewby made the discovery and wrote a letter, in order to prevent the plaintiff getting a patent.

Lord Justice JAMES: I understood at first that the injunction extended to the Beckton works only.

Mr. SOUTHGATE: To all our works, my lord; the injunction is general.

Lord Justice JAMES: So that you could not even carry on your works at Bow, in the old way, if the injunction stands?

Mr. SOUTHGATE: That is so; and I may tell your lordships that the plaintiff has intimated an intention of carrying in an account for damages against us for the Bow works.

Lord Justice JAMES: Then the case must proceed on the notion that the Bow works are an infringement as well as the other.

Mr. SOUTHGATE said the defendants having put in an answer, the plaintiff amended his bill, and he thought the court would be of opinion, when they heard the evidence, that the plaintiff, to a considerable extent, managed his own case. The affidavits in reply were something scandalous. In paragraph 32 of the amended bill he stated that the system at present in use at the defendants works was not introduced or used by them, and no precautions or methods whatever were taken by them to convert the lime in any one or more of the purifiers into sulphide of calcium, and thereafter to maintain it in that state, at Beckton, until some time after the date of his patent; he alleged that the action of sulphide of calcium in arresting the sulphur compounds was perfectly certain, and, within narrow limits, invaluable in its action; and he further stated that the official testing of the defendants gas both at Beckton and Bow, between October, 1871, and June, 1873, demonstrated that the allegations of the defendants as to the time when they adopted the system of purification now used by them was wholly untrue. In the defendants answer they asserted that the plaintiff could not claim the use of sulphide of calcium in separate purifiers, because that was a thing perfectly well known. But in arguing the case, his learned friend Mr. Kay completely changed his front, and claimed as the principal thing the use of existing apparatus, after converting them into sulphide of calcium purifiers. The evidence of the defendants showed conclusively that chemists had known for many years the action of sulphide of calcium, and that gas men had practically known it for a considerable period. It had been in operation at Bow since 1867, and the defendants had the specification of a patent of one of their managers (Mr. Mann), taken out three months prior to the plaintiff's patent, claiming the use of sulphide of calcium. This patent, however, was abandoned when the true state of things was discovered, and it was proved that there was no novelty in it. The learned counsel cited the case of *Ralston v. Smith*, in which Chief Justice Erle remarked that, although a patentee might have discovered how to use a machine more beneficially than the owner knew, he had no right to take a grant which virtually prohibited the owner from the exercise of an existing right over his own property. That was exactly the case here. The plaintiff did not specify any new make of purifiers; they were to be exactly the same; but what he said was, "You have not been working them aright; I will teach you how to use them more advantageously." Mr. Grove, in *Ralston v. Smith*, quoted the case of *Crane v. Price*, in which it was held that, producing from things and modes already known, more economical and better results to the public was good for a patent, yet that was only because there was, in that instance, a new and improved manufacture—viz., iron of a superior kind—produced. He quoted also the case of the *Patent Bottle Envelope Company v. Seymer*. The rule which the last case seemed to lay down was restricted in its operation, as it was held that the application of a well-known tool, to work previously untried materials, or to produce new forms, was not the subject matter of a patent. Again, in *Horton v. Mabon*, the application of a known article—double-angle iron—to the joints of telescopic gasholders, instead of two pieces of single-angle iron rivetted together, was held not to be a good ground for a patent, as it was merely a new form of applying known things, no new manufacture being produced. So, too, in *Brooks v. Aston*, the application of machinery to wool and hair, to which it had not been before applied, in order to produce the same results as had already been produced on cotton and linen, was held not to be the subject of a patent. In the case of *Ralston v. Smith*, it was said by Mr. Grove, and it could not possibly be disputed by any gentleman at the bar, that it was not every useful discovery that could be made the subject of a patent; but it must be shown that the discovery could be brought within the fair extension of the words, "a new manufacture." The learned counsel having quoted from the referees report of January, 1872, to show what had been done at the Bow works, proving, as he contended, a complete anticipation of the plaintiff's patent, said he proposed now to go through the evidence which was given in the court below.

Lord Justice JAMES: It really is a question of fact, except as to the point of law. You say that the claim under the second head is not the subject matter of a patent; and I understand you to say there is no evidence given in support of the other three heads. On that there may be some question of law.

Mr. FRY then proceeded to read the evidence-in-chief, which has been already reported in the JOURNAL at length. The first witness was the plaintiff himself. In one portion of his affidavit he referred to the issue of the instructions of the gas referees in March, 1872, when, for the first time, a sulphur maximum was fixed.

Lord Justice JAMES thereupon remarked: That is rather a curious position, if true. Apparently he was one of the referees who fixed the maximum, and he had got a patent by which alone it could be kept below the maximum.

Mr. FRY: Until they discovered that it might be done, they did not fix any maximum.

Lord Justice JAMES: And then they fixed it so as to compel the companies, if his patent was a good one, to adopt his process.

Lord Justice BAGGALLAY: I have not observed that there is any remark made by the plaintiff, upon the allegation in the defendants answer, that your patent process has never been put in practice by any other company, or that any other gas manufacturers have been using it.

Mr. FRY: Up to the present time I am not aware the plaintiff's process has been tried in gas-works.

Lord Justice BAGGALLAY: I was referring to the general allegation in the defendants answer, that until the institution of the present suit the plaintiff had never attempted to put the letters patent in force.

Mr. FRY: That is quite true, my lord; but, of course, one must have the first case.

Lord Justice BAGGALLAY: Has it been used in any other gas-works?

Mr. FRY: We believe it has.

The affidavits of Mr. Pierce, Mr. T. Foster, Mr. G. Livesey, Dr. Stevenson, Mr. Heisch, Mr. Gore, Mr. G. Anderson, and the cross-examination of the plaintiff, were then read. The specification of the plaintiff's patent was also read, and commented on.

On the second day Mr. DAVEY proposed to resume the reading of the cross-examination on the patent.

Lord Justice JAMES: The whole of the cross-examination, which was read yesterday, seemed to me to lead to this—that the whole of the plaintiff's knowledge was to be found in his specification.

Mr. DAVEY: It was put to him, my lord, whether he could explain certain words in his specification which we cannot explain, and which I believe nobody else can.

Lord Justice JAMES: It did not strike me that there was very much in it.

The reading of the evidence of the plaintiff, on cross-examination and re-examination, was then resumed and completed, and the evidence of the defendants witnesses was also read and commented on. This occupied the remainder of the second, and the whole of the third day. At the conclusion of the evidence, the court, without calling upon the appellants to address them, intimated that they should expect the respondents counsel to be ready, on the following morning, to support the decree of the court below.

On Thursday morning Mr. KAY accordingly commenced his address for the plaintiff. He said he would first of all deal with that part of the case which his learned friend, Mr. Southgate, referred to in his opening—viz., whether the position which the plaintiff occupied, was one that prevented him from taking out a patent. If there was anything wrong in the plaintiff accepting a patent, there would be ground for applying for a *scire facias* to recall the grant, but while the patent existed surely he had a right to maintain an action for its infringement. Even if he had obtained his patent for some reason or other wrongly, that could hardly be a ground for refusing to treat it other than valid while it existed. No proceeding had been instituted to recall the letters patent; and he apprehended, therefore, that if there was anything in the objection taken by his learned friend on that ground, this was a sufficient answer to it. He would leave this point, because he conceived there never was a more completely futile objection taken to anything than this objection. Now on what terms, and under what circumstances could any persons allege that they had a right to a patent taken out by another person, or that as against them his patent was wrong. Surely under no circumstances but these: either that he had, for valuable considerations, assigned or agreed to assign the invention to those other persons, or that he was in such a position that any invention of his became their property. He (Mr. Kay) was sure that he should receive their lordships assent to this, that the invention of one man could not be made the property of another, merely because that person had submitted to him a series of facts, upon which the first person's mind working had perfected the invention. It was familiar to their lordships, as it was to every one who had paid the least attention to the history of inventions in this country, that some of the most valuable inventions, especially in machinery, had been made by men who, at the time, were the paid servants and agents of employers, whose machinery they were watching, and who, by information received in the course of their employment, and by means of that stimulus to their intellect which was given by the paid employment in which they were engaged, were able to produce an invention. But he had never heard it alleged, and there was no case in the books which hinted at such a proposition, that the product of a man's mind, founded on facts and learned by him in the course of his paid employment, was less his own property because it took place under those circumstances, and he could not conceive for one moment that any one would be bold enough to contend, that because a paid servant, however completely his information might have been derived in the course of his employment, took out a patent, he had not a right to the result of that higher operation of intellect which involved invention. The same fact might be submitted to a thousand minds, and out of those thousand, nine hundred and ninety-nine might be barren of anything like invention, but the remaining one, on consideration of the facts, might invent a process or a new machine, or something which would be very valuable in science or art, and which might be a good subject of a patent. Surely that operation of the mind which invented the new process was the property of the man whose mind produced the result. The only way in which an inventor could be deprived of the profit of his invention, however it might have been stimulated, was either the circumstance that he had contracted beforehand to sell that invention for value, or that when it was made he had done something equivalent which made the invention, the product of his mind, the property of another. Supposing the curator of a library, who was paid for his duty, should, by means of having the use of the books of that library, be able to obtain information which qualified him to compile another book, would that new book be the property of his employer? The separate operations of a man's mind which evolved the invention, which was the thing rewarded, and very imperfectly rewarded by a grant of letters patent, enabling him to take the profit of it for a certain number of years, were as absolutely and entirely the man's property as anything could be, unless he had consciously and designedly parted with it for value. He (Mr. Kay) put that proposition at the outset, and it seemed to him to be one which it was impossible for one moment to deny in a court of law. Then the question resolved itself into this: Was the nature of the plaintiff's employment such that any invention made by any one of the referees relating to the purification of gas, became the property of the gas companies, whose money they were receiving? Because it must be put so in order to involve the propositions, which his learned friend had hinted at in his opening, which was distinctly put forward in the pleadings, and which, in the court below, was put as high as this, that if the plaintiff took out a patent under those circumstances, it was a fraud. Referring to the City of London Gas Act, he would ask their lordships, as he passed rapidly over the sections, whether there was in it the slightest hint of its being one of the duties for which the gas referees were paid, that they should invent new processes for purifying gas? Before that Act was passed, there had been an Act—the Metropolis Act, 1860—which fixed the maximum of sulphur at 20 grains per 100 feet; but that provision, it was shown by the defendants evidence, had been from the first a dead letter, because none of the companies had been able to work within that maximum. When the referees were appointed under the Act of 1868, one of their duties was "from time to time to ascertain with what degree of purity each company can reasonably be required to make and supply gas continuously without occasioning a nuisance to the neighbourhood in which the works are situated, and shall thereupon prescribe and certify the maximum amount of impurity in each form with which gas supplied by the company shall be allowed to be charged." They were to fix a maximum which might, according to the Act, be a varying maximum in different gas-works, and that was their principal, if not their only object, and it was evidently introduced into this Act because the Legislature admitted that anything like a rigid rule in the then state of knowledge was impossible, and that the fixing of 20 grains per 100 feet in the Act of 1860 was an ill-considered thing. The duty of the referees was not to invent anything, not to advise anything, not to devise anything, but in any way to investigate the process, nor for any other purpose than this, to find out what, in a reasonable manner, each gas-works could do with reference to sulphur impurities, and then fix a maximum. Was there in all this anything which amounted to a purchase by the companies, or any of them, of any

invention which the referees, or either of them, might make in the process of the transaction?

Justice LUSH: You say that if one of the referees knew, or thought he knew, of a mode by which a particular company could supply purer gas, it would not be his duty to insist upon that company trying that mode. And you say that if he knew of a mode which he thought would work well, he could go and get a patent for it.

Mr. KAY: If the new mode was his own invention, and if it was one for which he would be entitled to ask for a patent, had he not been a referee.

Justice LUSH: He was paid for ascertaining their capacity to make purer gas, and with power to order them to make what experiments he pleased.

Mr. KAY: Not to make experiments for the purpose of improving the process, but for ascertaining the amount of sulphur and ammonia impurities in the gas supplied by them. And it is a fact, which was referred to in the court below, that another of the referees, Mr. Vernon Harcourt, has also taken out a patent, and I have heard of no objection to that.

Justice LUSH: The referees are to ascertain what particular degree of purity any company can reasonably obtain in their gas.

Mr. KAY submitted that that did not prevent any one of the referees from obtaining the only remuneration which the law gave an inventor, if he discovered or invented an entirely new process. Was there anything in the Act of Parliament which put him under the least obligation to assign any patent he might take out to the gas company.

Lord Justice BAGGALLAY: There would be nothing to prevent an officer in the Artillery or in the Rifle Volunteers taking out a patent for something new that he discovered in ordnance.

Mr. KAY: The men who make inventions are generally men whose attention has been called to the subject by some paid employment. Your lordships will remember Captain Boxer, who took out several patents at the time he was in Government employment, and was it ever heard or thought of that Captain Boxer was bound to assign his patents to his employers?

Lord Justice JAMES: I do not know that that is the real difficulty. Mr. Patterson is not a single individual engaged in this duty; he is one of a body of men who, in the discharge of their duties, come into confidential communications with the manufacturers, and, whether or not it is their absolute duty so to do, the result is that they are constantly interchanging their ideas, and opinions, and views, as to the best mode of obtaining purity in the gas. The question is whether he, getting a knowledge from them, and they getting knowledge from him, and interchanging their ideas, he is in a position to say that he is the first inventor.

Mr. KAY: That involves a different question—viz., whose was the invention?

Justice LUSH: Supposing he requires them to make experiments, with a view to finding out their capability, and they obey him, and find that the mode he has suggested is a good one, what would you say then?

Mr. KAY: I say frankly that, in that case, they could not say the invention belonged to them.

Justice LUSH: It did not occur to me that they could treat the invention as their own: but it goes to the novelty.

Mr. KAY said he would deal with the question of novelty separately. The point he was upon now was, that the plaintiff was under no obligation to assign the result of his invention to his employers.

Lord Justice JAMES: The companies were not his employers.

Mr. KAY: That is another answer to it; they say they paid him.

Lord Justice JAMES: They did not pay him; they were taxed.

Mr. KAY said the Government would be the right persons to claim the patent, if any claim could be established; and on this point he thought they might wait till such a claim was made.

Lord Justice JAMES: Before you leave the question of my suggested personal disqualification of the plaintiff, either now, or at some future time, would you address yourself to this question—whether the plaintiff, being in possession of an invention which it had become absolutely necessary for the gas companies to use, in order to comply with the limits of 20 grains of sulphur, and, being in that state, keeping back his invention until such time as the maximum of 20 grains is fixed, and then bringing out his patent so that the gas companies cannot comply with the restrictions as regards the quantity of sulphur in the gas, without becoming the licensees of his patent—whether, that state of circumstances existing, the plaintiff can come to a court of equity to enforce it?

Mr. KAY: That is not precisely what the fact is. The maximum was fixed after the patent was published.

Justice LUSH: But the report was kept back until that time.

Mr. KAY: The report was kept back because it contained a description of the patent, the specification of which would not be made public till six months afterwards. The report was published on March 26, and the patent was taken out on the 9th, but the maximum was not fixed until the 1st of October.

Lord Justice BAGGALLAY: I do not think the order of date is important. It is the combination of the two processes.

Mr. KAY said he was arguing this part of the case upon the assumption that the process was *bonâ fide* the invention of the plaintiff. Was there any wrong done to the company by what he did? It would be found that the parties were under the greatest possible pressure from the Metropolitan Board and Corporation of London to have a maximum fixed, and that maximum as at first fixed was not a low one; it was 30 grains per 100 feet, and according to the defendants own evidence they were able, with certain exceptions which they could not account for, to keep within that. It was not till afterwards, when they had adopted and were using this process, that the limit was reduced. If the patent were a good one, and if there was no wrong in Mr. Patterson taking out a patent, how could there be anything wrong in fixing such a limit as 30 grains? It was not *these referees*, but it was after *these referees* office had ceased that the maximum was fixed at 30 grains in winter and 15 in summer. How could there be anything wrong in that? Supposing the referees had fixed the maximum under which it was impossible to work just before the patent was taken out, it was not the patent of the referees; it was the patent of one of them. Supposing they were convinced that by this patent the companies, if they chose to use it, could work within that limit, was there anything wrong on Mr. Patterson's part, or on that of any one of the referees who joined in fixing that maximum? If there was anything wrong, it was as though the invention itself was wrong. But if the invention was not wrong, there could be no wrong in the inventor obtaining the remuneration which the law enabled him to get in only one way—viz., by taking out a patent. Everybody who had attended to the subject admitted that this was a very imperfect way of remunerating an inventor, but still it was the legal way, and how, therefore, could there be any wrong influence with the other two referees fixing a maximum which could only be obtained by the use of this patent? After all, it came to this: There was a patent in existence, and supposing it to have been the patent of any other man, the referees might have said, "There is a patent in existence by which it can be done, if you choose to use it."

Lord Justice JAMES: Yes, if you choose to pay whatever that man asks. If he asks you for a million you must pay it.

Mr. KAY: No doubt if they used it they would have to pay him what he asked. But your lordships can easily suppose that, if a man were to ask anything entirely unreasonable it would not be worth their while to use it, and they had better submit to such a penalty as the Government would impose upon them. Your lordships will also remember that the maximum was wholly in the control of the Government who fixed it.

Lord Justice JAMES: You say, "under the control of the Government." I thought it was under the control of the referees.

Mr. KAY: It is variable from time to time.

Lord Justice JAMES: By whom?

Mr. KAY: By the referees. But these referees did not continue; new ones were appointed, and surely, if there had been any undue action on their part for the purpose of getting a profit for any one of them, they could have been dismissed by the Government. It was not possible that any fraud, or wrong, or injury could be done, and if the referees had attempted to play into the hands of one of their number by fixing a maximum which would compel the gas company to use his patent, and pay him whatever he chose to ask, knowing that he would ask something unreasonable, it might have been instantly corrected by appointing other referees, and altering the maximum. Or another mode of correcting the mischief would have been to apply, under the terms of the Patent Act, for the recall of the grant. By that Act, it was provided that if it was proved to the satisfaction of the Privy Council that the grant was contrary to law or prejudical or inconvenient to Her Majesty's subjects, it might be recalled. But it was idle to say there was anything wrong, or that Mr. Patterson had made any claim for an unreasonable remuneration in respect of his patent. The learned counsel proceeded to discuss the question of novelty, and submitted that, according to the practice of this court, when the plaintiff swore that he was the first and true inventor, the affirmative issue was on him, and the defendants might meet that either by cross-examining him and showing that it was not true, or by giving particulars of objections, and proving instances of prior user. But if the plaintiff's case was not met either by destroying his testimony on cross-examination or by proving instances of prior user, of which particulars had been given, he was entitled to succeed. After some discussion on the point of practice, the learned counsel dealt with the defendants answers concerning claims 3, 4, and 5 of the plaintiff's patent as to novelty, prior user, &c., and read portions of the affidavits thereon. At the finish—

Justice LUSH asked: Is that all the evidence?

Mr. KAY: I believe that is all.

Justice LUSH: Then it stands thus—plaintiff says, "I never tried this; I am sure nobody else ever invented it before, and I believe it will work well."

Mr. KAY: "And I have tried experiments."

Justice LUSH: No. "I have never tried them in gas-works at all; I have only made suggestions." Dr. Stevenson says, "I never heard of it, but I believe it will work well." Mr. Heisch says, "I believe it will work well." Mr. Evans says, on the other hand, it has been tried and abandoned. Mr. Trewby says the same. That is the evidence on both sides, the plaintiff having the burden of proving the novelty and utility of his invention.

Mr. KAY submitted that if the plaintiff had made only a laboratory experiment, and found that it produced the result aimed at, he might take out a patent for the process without first trying it practically in gas-works.

Justice LUSH said the plaintiff, if he considered his invention so valuable, would surely have thought it worth while to try it. He took upon himself the burden of proving to the court that his patent was good. It was challenged, and surely he ought to have it in his power to say that he had tried it and found it useful. He simply said, "I believe it will answer, but I have never tried it."

Lord Justice BAGGALLAY: He said he tried it with as much sulphur and sawdust as he could put in a tumbler.

Mr. KAY: If it acts on a small scale, why not on a large scale?

Mr. SOUTHGATE: That certainly does not follow.

Justice LUSH: He seems to think the experiment will not help him out, because he takes care to say that he has never tried it in any gas-works.

Mr. KAY: Because, if so, he would be trying it under a very great danger of not being able to take out a patent afterwards.

Justice LUSH: And also under the danger of its turning out to be useless.

Mr. KAY submitted that in the absence of distinct evidence of the thing ever having been tried by any one before the patent was taken out, the plaintiff had given sufficient *primâ facie* evidence of its novelty. As to the question of utility also, he thought the plaintiff had established his case, unless their lordships should hold that an invention could not be patented until it had been tried on a manufacturing scale.

Justice LUSH remarked that the patent was dated in March, 1872, and the plaintiff's affidavit not filed until March, 1875, and therefore he had three years, during which this very point was litigated, to put his patent under trial and to provide evidence of its utility, so that when at the end of three years he came with such evidence as had been read, the question was whether he was entitled to prevail against the direct evidence on the other side.

Mr. KAY said the plaintiff was not a gas manufacturer, and might not be able to get one to take it up.

Lord Justice BAGGALLAY said the plaintiff told them that the directors of the gas company co-operated with him in the most cordial manner, in the making of experiments—that they bore the expense of them, and that their engineers did everything in their power to render his investigations accurate and complete. There could be no doubt, therefore, that they would have done this also.

Justice LUSH asked whether the learned counsel had ever known a patent case in which the novelty was disputed, and where the utility was disputed, in which the patentee had obtained a verdict, without proof that the patent had been tried and found useful?

Mr. KAY said he would leave the reply to his friend Mr. Aston, who had had more experience in these matters than he had. The learned counsel proceeded to urge that the gas companies were not likely to assist his client in trying his patent on a practical scale; that the plaintiff had done all that was in his power, and his patent ought not to be voided on the grounds alleged. Dealing with the main features of the case—viz., the first and second parts of the patent, and to the objections—first, that the plaintiff's claim was too general; and second, that his invention or discovery was not the subject of a patent—the learned counsel went over the whole argument submitted to the court below. This has been so recently reported at great length in these columns, that it is not necessary to repeat it. He also cited several cases in support of the legal points raised throughout.

On Monday, the 15th inst., Mr. KAY resumed his address for the respondent. He said the remaining question in the case to which he invited their lordships attention was that which to his learned friend on the other side was the most important of all—viz., whether or not the invention of Mr. Patterson was new at the date of his patent. It was alleged that it was not new, and there were instances referred to on which that allegation was based. Those instances, speaking generally, were three. First it was said that what had been done at Beckton was an anticipation; secondly, that what was done at Bow was an anticipation; and thirdly, that Mr. Mann's patent was an anticipation. Respecting the first, the learned counsel referred to the report made by the referees on sulphur purification at Beckton, and to the correspondence which was put in evidence at the hearing before the Vice-Chancellor, to show, as he contended, that the mode of purification there, down to 1870, was such that it could have no effect whatever upon the sulphur compounds. It was evident, he said, that at that time they had not the faintest idea of the plaintiff's process.

Lord Justice JAMES: They may not have had the least notion of the principle of the process, but this does not touch the fact that at Bow the defendants were then doing precisely what they are doing now.

Mr. KAY said he would deal with that presently, but if at Bow the plaintiff's principle was understood, and the process in use, you cannot conceive——

Lord Justice JAMES: That is a different thing. The process might have been there, though the principle was not understood.

Mr. KAY: It is clear that they began at Beckton with the oxide of iron first,

and the lime afterwards. That process was abandoned because it was found to be wrong.

Lord Justice BAGGALLAY: The oxide of iron was only used at Beckton from April, 1870, to August, 1871.

Mr. KAY said he would give the reason why in a minute, but what he wanted their lordships to understand was that Mr. Trewby knew well all that was done at Bow, and he had so little confidence in it that the processes he employed at Beckton were such that they could have no possible effect on anything except the sulphuretted hydrogen. In fact, all the experiments made up to 1872 failed. He (Mr. Kay) only referred to these matters to show what the state of knowledge was at the time. In 1872, when, as it was alleged, there was an anticipation of the plaintiff's patent by what was done at Beckton, there was a circular issued by the referees in January, asking for the results of any testings that might have been made for carbonic acid at the inlets of the purifiers. To that circular Mr. Trewby replied that no such testings had been made. That was on the 31st of January, and the report that was sent in to Parliament, in which was disclosed Mr. Patterson's process, was completed at that time.

Mr. SOUTHGATE said he could show that it was subsequently revised.

Mr. KAY said neither himself nor his learned friends with him knew of such revision. The report was not sent in to the Board of Trade till after the 9th of March, because the referees were waiting for a report that was promised them from Beckton.

Lord Justice JAMES: Upon that there is rather a conflict of evidence. It was said there was an understanding between the plaintiff and his colleagues that it was to be kept back, in order to allow the plaintiff to take out his patent first.

Mr. KAY said the real fact was they were waiting for the testings in answer to their circular.

Lord Justice JAMES: To my mind it really amounts to nothing. With regard to Beckton, the thing was this. The patent was not taken out till the 9th of March. Even then it appears there is a letter of Mr. Trewby, on the 17th of February, in which he gives the very principle, and says: "It is the carbonic acid that is the cause of all the difficulty; but I have now put two purifiers for carbonic acid, and two for sulphuretted hydrogen."

Mr. KAY: I am going to deal with that letter, and what he did.

Lord Justice JAMES: Is that letter true? because, if that letter is true, there seems to me to be nothing in the case.

Mr. KAY said it was evident that the whole of the invention was perfected in Mr. Patterson's mind, and had been reduced into form and put into words in the report of the 31st of January. It was perfectly clear that at that time he had perfected his invention, and was intending to take out a patent. On the 15th of February he wrote a letter to Mr. Trewby, to which this was the answer, and everything which Mr. Trewby said was in consequence of that letter.

Lord Justice JAMES: You say he wrote to Mr. Trewby and said, "Try this." Mr. Trewby, on the 17th of February, writes, saying what he had done, and what he had discovered.

Mr. KAY: Not what he had discovered, but what he had done.

Lord Justice JAMES: He gives the same explanation. Mr. Patterson writes to Mr. Trewby, and tells him to try a certain process; and then there is evidence that anterior to this Mr. Patterson, in one of his letters, said, "I send you a copy of the report; but all the suggestions in it have been communicated months ago to Mr. Trewby and others."

Mr. KAY said the letter written by Mr. Patterson, on the 15th of February, to Mr. Trewby, said: "As carbonic acid has a greater affinity for lime than sulphuretted hydrogen has, it may be confidently expected that a tray of clean lime will take out carbonic acid in greater proportion than it takes out sulphuretted hydrogen. In this way the relative amount of the two elements may be altered so as to bring down the carbonic acid in greater proportion; say, instead of carbonic acid = 4 and sulphuretted hydrogen = 2, we might have carbonic acid = 2·5 and sulphuretted hydrogen = 1·5. This, of course, would greatly improve the action of the lime purification. This might be tried experimentally by passing the gas from the scrubbers through a tray of clean lime, and testing to see the carbonic acid and sulphuretted hydrogen in the gas both before and after. Or perhaps you might pass all your gas in each purifying-house through one purifier first, and changing the lime in this one quickly as the back pressure shows it turned into carbonate, or else as soon as it gets foul." That was a suggestion of one part of the plaintiff's process to be tried experimentally.

Lord Justice BAGGALLAY: Assuming there is no question as to the terms of this letter of the 15th of February, which described any of the inventions afterwards patented by the plaintiff, and assuming that three or four days afterwards Mr. Trewby did what Mr. Patterson described, could the patent of the 9th of March stand?

Mr. KAY: I admit there might have been a difficulty then, but the fact is it was never put into operation; and then it is proved beyond question that whatever he did was not successful.

Lord Justice JAMES: That may be so.

Mr. KAY: Whatever he did, he altered it very shortly after trying it. He did not continue to use this process, but an entirely different one.

Lord Justice JAMES: It was in use on or before the 9th of March.

Mr. KAY: My lords, I utterly deny that as a proposition or fact in this case. It never was in use. It never was used by Mr. Trewby or anybody else. That is the real evidence in the case.

Lord Justice JAMES: Is it?

Mr. KAY said that was the proposition he was going to submit to their lordships and to support. The evidence showed that whatever Mr. Trewby did, this suggestion of an experiment was made by Mr. Patterson. On a former day the question was put to him (Mr. Kay) by the court, why Mr. Patterson did not get his invention tried on a manufacturing scale. His answer was, that there might have been some danger in doing so.

Lord Justice JAMES said the question put to the learned counsel was not why he did not get it done before his patent was taken out, but between the time of taking out the patent and the time of getting evidence.

Mr. KAY: Was it ever heard, or is it a proposition of patent law that can be supported for one moment, that if a man makes an invention, and gets a company to try an experiment for him, he being ready at the time to take out a patent, this experiment would be an anticipation of his invention.

Lord Justice JAMES: The experiment was not one which was asked by him as an inventor. He was a referee, and it was his duty to ask them to do it, and his letter was a letter from him, as a referee, to the company whom he was supervising, saying, "You have not succeeded, try that." It is impossible to put this as a confidential experiment.

Mr. KAY: I do not want it confidentially at all. If it was merely a trial of his experiment it would not be a part of his patent.

Lord Justice JAMES: Of course, if it was tried it would be an anticipation.

Mr. KAY, quoting from the letter, asked: Is not that an experiment?

Lord Justice JAMES: No; it is really telling the manufacturer "Do this," and the manufacturer does it.

Mr. KAY: As an experiment.

Lord Justice JAMES: Whether as an experiment or not, it is not an experiment made by him, or his servant, or his confidential friend. He tells all the world—that is to say, he tells Mr. Trewby, and Mr. Trewby could have gone and told it at Bow, or anywhere else.

Mr. KAY: Even if it had succeeded, would it be an anticipation of his patent?

Lord Justice JAMES: I should say as plainly an anticipation as possible.

Mr. KAY thought it would not be, and proceeded to refer to the evidence on this part of the case. Having done so, he submitted that on Mr. Trewby's own showing that he was not practising the plaintiff's process at the time the patent was taken out.

Lord Justice JAMES: He was doing it, but not doing it enough.

Mr. KAY: Not doing it enough is not doing it at all.

Lord Justice JAMES: He was using the one process for carbonic acid, and he was using the other for sulphur, but he did not change them quickly enough.

Mr. KAY: That makes the difference between success and failure.

Lord Justice JAMES: That is not the subject matter of a patent. He was doing then exactly what he is doing now.

Mr. KAY: No, he was not doing at all what he is doing now. Now he is taking out carbonic acid entirely by the first purifier in the series, and then let the gas go on with the sulphuretted hydrogen and sulphocarbons in it.

Lord Justice JAMES: He took out certain portions, and did not take out others.

Mr. KAY said his argument was that it was essential to the plaintiff's process that the carbonic acid should be taken out entirely, or as nearly so as practicable, in in the first purifier, which Mr. Trewby was not doing. After referring at great length to the evidence, the learned counsel submitted that Mr. Trewby did not adopt the suggestion of Mr. Patterson, and that his own record proved he did not even test for carbonic acid till May, 1872. He then proceeded to the evidence as to what had been done at Bow, which was alleged to be an anticipation, and contended that on the defendants witnesses own admissions, from 1867 downwards, they were doing at Bow precisely that which the plaintiff's patent was intended entirely to reform and do away with—viz., leaving the lime, ignorantly, in the purifiers for such a time as would prevent its action upon the sulphocarbons in the gas. He said he would show the court how things were conducted at Bow, and when a change took place—a change which he should submit involved an infringement of the plaintiff's patent, although it was not necessary for him to make that out, there being admissions enough in the evidence for that purpose. On this point he read further parts of the examination of Mr. Harris and Mr. Carpenter, to prove that nothing done at Bow until May, 1872, was done according to the plaintiff's process, and that what they had done there since was a direct infringement of his patent. He said he would now refer to the third alleged anticipation—viz., the patent of Mr. Mann.

Lord Justice JAMES: I do not think you need trouble yourself about that.

Mr. KAY: That patent was dropped; it never was worked.

Lord Justice JAMES: It was only put forward in this case to prove previous knowledge that sulphide of calcium would absorb sulphocarbons.

Mr. KAY: That is a chemical fact I have never disputed. I will only now trouble your lordships with a few cases on the subject of whether an experiment being made is an anticipation.

Justice LUSH: I hardly think we require authorities on that.

Mr. KAY, however, referred to two or three cases in support of his views, and concluded his address by remarking that if the court should consider the plaintiff's patent to be a valuable patent upon the first two claims, he should very confidently submit to their lordships that the state of the evidence on the claims 3, 4, and 5, was not such as to induce them to invalidate a patent otherwise good, although they might doubt whether, if the processes described were actually used, they could be useful in gas purification. He thought the plaintiff had made out his case for claims 1 and 2 clearly; that it had not been displaced on claims 1 and 2, or 3, 4, and 5, and he therefore submitted to their lordships that the decree of the Vice-Chancellor should be supported.

Mr. FRY followed on the same side, and commenced by reading the judgment of Vice-Chancellor Bacon, commenting upon it as he proceeded. Having done so, he said he would make one or two observations with regard to the personal objection which had been taken to the plaintiff. He thought his learned friend, Mr. Kay, had satisfied the court that there was nothing whatever in this objection. He could understand the point if it were put in this way, that a person with a very delicate sense of honour, occupying the position of a referee, might feel that his duty towards the public might prevent his taking out a patent which would enure for his private benefit; but how could that observation be made by these persons, who certainly were neither his masters nor employers? because it was quite clear that Mr. Patterson was never the servant of the defendants. It was quite true they and other gas companies paid him, but they paid him in this manner:—The Legislature thought fit to make that a condition of their appointment, because the gas companies were great offenders against the public, and it was thought that this would be the means by which a check could be put on them against doing that which was offensive. To make them pay the referees was putting a check on them as a penalty for their reformation. Mr. Patterson was not the servant of the company, and his payment was, in effect, the consideration given by the company for the abandonment of the maximum fixed by the Act of 1860. In effect, they came to the Legislature and said, "Relieve us from this fixed impost, this hard and fast line which is pressing unfairly and unduly upon us; if you do that we will pay for proper skilled persons who shall fix a maximum." That was the bargain between them and the Legislature, and there was nothing in that bargain which made Mr. Patterson or any other of the referees a servant of the company.

Justice LUSH: It was simply, "We submit to the tax."

Mr. FRY said even if it were otherwise, there were cases perfectly familiar to their lordships in which it had been held that a servant gaining information in the employment of his master was entitled to the whole of his patent rights. But in the present case there was nothing which a man of the most delicate honour would shrink from having done, because Mr. Patterson having made the discovery, and having obtained letters patent, went to Mr. Phillips, the secretary, in a friendly spirit, showed his letters patent, and said that as long as he was a referee the company should have the use of the invention on moderate terms. The next point upon which he (Mr. Fry) would say a word or two was as to the non-utility of the 3rd, 4th, and 5th heads of claim, and he would submit that the Vice-Chancellor was right in his conclusion that this was not an adequate mode of raising the issue, if issue was intended to be raised. What was the issue which a defendant must raise with regard to utility to make it a proper and relevant issue? It must be a traverse and absolute denial of any utility at all. The issue the defendants raised in this case was as to their belief of the practical utility.

Lord Justice JAMES: It would be no evidence, but it surely raised the issue, and the plaintiff has admitted it by going into evidence upon it.

Mr. FRY cited several cases to prove that it had been held that the court would not consider the proportion of utility, but that any utility would do. He submitted on these grounds that the Vice-Chancellor was right in the conclusion he came to, that it was not incumbent upon the plaintiff to give any further evidence than he did. He would only add that he believed their lordships would be very unwilling to decide a case of this importance on the 3rd, 4th, and 5th heads; because they knew, if that were done, the Attorney-General would, on the plaintiff's application, strike those words out of the patent by disclaimer, and the case would have to be re-tried on the other parts of the claim.

Lord Justice JAMES: We shall express our opinion on the whole case. Having gone through it in detail, we shall feel it our duty to do so.

Mr. FRY said if their lordships should think that was the only objection, they ought to allow the plaintiff the opportunity of amending by way of disclaimer. With reference to the next point, which he conceived to be by far the most important of all the difficulties presented by the defendants in the way of the

plaintiff, he would only say a few words. If he read rightly what was passing in their lordships minds, they were inclined to hold, as to the second head, that the objection, that the invention of the plaintiff was not a good subject of a patent, ought to prevail. It appeared to him to occur to their lordships minds in this way—that for years a process had been going forward, which, under certain circumstances, and in certain cases, produced the very same results which the plaintiff's patent would effect, and that the plaintiff could not select one out of the large number of methods of using particular machines, and say to the persons who before that patent could have used the machine in any manner they liked, "You shall not now use it in a particular manner which is useful;" in other words, where there was an existing machine, and an existing process, a person could not say to the owner of that machine, and the owner of that process, "You must henceforth not use it in the most beneficial manner." He submitted, however, that it really was a subject of a patent, when a person finding a thing done without method, discovered the method which would be effectual, and when he indicated the manner in which his method could be brought to bear upon that process. He supported his argument by reference to the cases of Young's paraffin oil patent, the Muntz metal patent, and Hills's oxide patent, and having gone through the defendants evidence of what was done by them prior to the plaintiff's patent at Bow and Beckton, together with the evidence on Mann's patent, and Dr. Odling's statements in his lecture to the Gas Managers Association as to the previous state of knowledge on the subject of sulphur purification, he concluded by asking their lordships to decide that the processes carried on at Beckton and at Bow were not, at the date of taking out the letters patent, substantially, or in fact, the same as those described by the plaintiff, and that the alteration at Beckton was not begun till the 20th of May, and those at Bow until March 22, 1872; that therefore there had been an infringement by the defendants of the plaintiff's patent.

On Tuesday, May 16, on the assembling of the court.

Lord Justice JAMES, in delivering judgment, said: This suit has been instituted under very peculiar circumstances. The plaintiff was one of a body of public officials, appointed under the provisions of the Metropolis Gas Act of 1868, called the gas referees. Their powers, functions, and duties, so far as it is material to refer to them, are contained in the following sections of the Act:—"The gas referees shall, subject to the provisions of this Act, from time to time prescribe and certify the mode to be adopted for testing and recording the illuminating power of gas supplied by the companies, and the number of the times of testing. The gas referees shall, with all practicable speed after their appointment, and the gas referees for the time being may from time to time thereafter inspect the works of the companies, and investigate the processes of manufacture carried on therein with the view of ascertaining the means adopted therein for purifying gas and for preventing nuisance, and may from time to time apply all such tests as they think expedient, at the works of the companies or elsewhere, for ascertaining the amount of sulphur and ammonia, and of compounds thereof, or other impurity with which gas supplied by them is charged. The companies shall give to the gas referees and each of them, and to their clerks, servants, and workmen, access to the works of the companies, and shall when required afford to them and him all facilities for the proper execution of their and his duty. The gas referees shall from time to time ascertain with what degree of purity each company can reasonably be required to make and supply gas continuously without occasioning a nuisance to the neighbourhood in which the works are situate, and shall thereupon prescribe and certify the maximum amount of impurity in each form with which gas supplied by the company shall be allowed to be charged, and the time from which the allowance thereof shall be enforced as against each company, regard being had to the necessity for any alteration of works by a company consequent on any such certificate."

In the performance of his duties, the plaintiff was in constant communication with the managers of the metropolitan gas-works, and became intimately acquainted with their processes and their results. As the object of the appointment of the referees was to secure for the public, gas of the utmost purity which could reasonably be required of the companies, it was, of course, their duty to ascertain what, under all the circumstances of each case, would be a reasonable requisition, and in the performance of this duty to discuss with, and to suggest to, the managers as practical men, and to discuss with, and to suggest to, one another the existing impurities, the probable causes of them, and the best means practically available for removing such causes.

The gas companies had failed to supply to the public a gas which did not contain a very considerable amount of sulphur, and not only was that amount excessive, but the gas showed, according to the plaintiff, variations in that amount from day to day which the makers could not account for. With the same coal, the same process of manufacture, the same purifying process, the gas came out sometimes very pure and sometimes very impure. Revolving these things in his mind, the plaintiff says that he discovered the cause of the defect, and with it a simple and effectual means of removing such cause. The discovery may be stated shortly thus: after a certain preliminary process of purification in what are called washers or scrubbers, the gas, which was still very impure, containing a large quantity of carbonic acid, sulphuretted hydrogen, and other sulphur, was passed through purifiers containing lime and oxide of iron. The oxide of iron would absorb and remove sulphuretted hydrogen, but it had little or no effect on the other sulphur compounds. The lime was capable of absorbing the carbonic acid and also the sulphuretted hydrogen, but had no effect, as lime, on the other sulphur compounds; but in absorbing the sulphuretted hydrogen it became sulphide of calcium, in which state it was a very efficient agent for removing the other sulphur compounds. The lime was, therefore, capable, first as lime and then as sulphide of calcium, of removing the carbonic acid and the sulphuretted hydrogen, and to a great extent the other sulphur compounds. But the plaintiff, as he alleges, discovered that a great chemical truth had been overlooked or neglected—namely, that carbonic acid would decompose sulphide of calcium, and set free again the sulphur which had been absorbed; and he, therefore, discovered, what had been overlooked, that it was essential that the gas should be entirely deprived of its carbonic acid in the first instance. The lime in the subsequent purifier, or purifiers, would then be partly pure lime and partly sulphide of calcium. The lime would go on absorbing sulphuretted hydrogen until it became wholly sulphide of calcium, and the sulphide of calcium would continue taking up the other sulphurs. When this truth presented itself to the plaintiff's mind the remedy was very obvious. From the great affinity between lime and carbonic acid it is easy to absorb the latter, and, practically speaking, carbonic acid would not escape from a vessel containing lime unless and until the latter had been converted into a carbonate. Having satisfied himself by deduction and by experiments that the solution of the sulphur difficulty was to be found in the proper use of the affinity between carbonic acid and lime, he confidentially informed his colleagues of his discovery, and, as alleged, "It was with his permission that the description of his lime process was given in the report next to be mentioned," and with a perfect understanding on their part that he was to take out a patent for his said discovery before the issue of the report. The report contains the first statement of the discovery, and is the first piece of writing in which anything is formulated with respect to it. That report bears date the 31st of January, 1872, and appears to have been in print about that time. In that report, no mention is made by the referees of any special discovery by one of them, or of any intention to patent it by any of them. The report is a long document. It is headed—"Report on Sulphur Purification at the Beckton Gas-Works, by the Gas Referees." It is sent from their official offices, 21, John Street, Adelphi; it is dated Jan. 31, 1872, and purports to give an account of what had been done at the Beckton works of the defendants, and, under the head of "Remedies," it proceeds thus: "The prime object to be sought is to utilize and perfect the existing processes of purification; for, if these can be made to yield satisfactory results, the interests of the public require that this should be accomplished in preference to the introduction of other processes which would increase the cost of gas manufacture. The referees feel confident that such a result is attainable. From experiments which they have made, they can state that lime in the form of sulphide of calcium (*i.e.*, saturated with sulphuretted hydrogen) is a perfectly adequate purifying agent for 'sulphur.' In their laboratory experiments, they are able in this way to wholly remove the sulphur (about 26 grains per 100 feet) from the gas supplied to their office. So great a result, of course, cannot be expected in gas-works—indeed, even in their laboratory experiments, they found that the purifying power of the material decreased on each subsequent day, owing doubtless to the carbonic acid in the gas (about 1 per cent.) gradually nullifying a portion of the material by converting it into carbonate of lime. Nevertheless, making due allowance for the difference between laboratory experiments and purification on the manufacturing scale, the referees feel assured that perfect results would be obtainable from the lime process of purification, *if carbonic acid were excluded from the purifiers;* and also that *the result will be adequate to the requirements of the public, if the carbonic acid which enters the purifiers be kept down to the lowest point actually attainable in gas-works.*" Then they proceed further with the suggestions of the remedies. The experiments are described as the experiments made by the referees at their office, and all the recommendations and suggestions are made as the official recommendations and suggestions of the whole body based upon facts officially ascertained for and by them, and the whole report purports to be the production of the whole body, and each of them applying, as in duty bound, his intellect and mind to the subject. The report was kept back from the official authorities until the 26th of March, and a few days afterwards it was circulated amongst the gas companies and generally. It would have been immediately the duty of the officers of the gas companies to adopt the suggestions of the report (if they had not previously done so), and it became immediately the duty of the referees to fix the maximum of impurity to be permitted, having regard to the means suggested by them. The plaintiff says that in fact this was done; that such a maximum was fixed; and that the defendant company did adopt, and with great success, the plan of the referees. For months the report was discussed, written about, and lectured upon as the referees report, and it is in subsequent reports referred to by that same designation. It was an official document, emanating from the plaintiff and others, inviting and intended and calculated to compel the gas companies to use the means therein described, and without any intimation that there was any patent right or private property, of the plaintiff or any one, in that which, to all appearances, was given to the public as public property. It appears, however, that, on the 9th of March, the plaintiff had presented his petition for letters patent, for "Improvements in the Purification of Coal Gas," lodging the usual provisional specification. Letters patent were sealed on the 28th of May. On the 11th of September, the complete specification was lodged, and then it appeared that the plaintiff had obtained a patent for that which was, in substance and effect, the referees report; and he has filed a bill against the defendants for having infringed such his patent rights by doing the very thing which they were so officially instructed, invited, and, in effect, commanded by him to do.

Although it is not necessary, for the determination of this suit, to pronounce any final decision on this point, we deem it right to say that we think it, at the very least, very questionable whether it can be competent for a member of an official commission or committee to take out a patent for the subject matter of their official investigations, for the results of such investigations embodied in their official report to the public authorities, or to treat as piratical infringers those who have adopted and followed the suggestions and directions contained in such report. The suggestion that the report was kept back for the purpose of enabling one of the referees to apply for a patent, is not entitled to much favour. It is to be borne in mind that the report, when made, belonged absolutely to the State. Every fact and figure in it had been ascertained and obtained at the public expense. Every hour of every referee and of the secretary employed in the production of it was public time. It was, of course, printed at the public cost. The withholding or wilful delaying of it was a plain breach of public duty, and it is difficult to see how the plaintiff can be in a better position than if he and his colleagues had done their duty, and duly presented their report as soon as it was completed. The consideration for every patent is the communication of useful information to the public. What consideration was there when the information was already the property of the State? The specification of the patent claims five distinct matters. If one of them is bad (as there has been no disclaimer), of course the patent must fail, and the defendants insist that every one of them is bad. The first claim, taking it from the specification, is this—"This invention relates to the purification of coal gas from sulphur in other forms than that of sulphuretted hydrogen by means of sulphides of calcium (as distinct from the material called 'gas' lime or 'foul' lime, which may be, and, under the existing methods of working lime purifiers, is always partly carbonate of lime) employed in separate purifiers." Then, with regard to that, he says: "Sulphide of Calcium Purifiers.—A purifier (or purifiers) is used containing pure sulphides of calcium, into which the gas is passed after being purified from sulphuretted hydrogen and carbonic acid for the purpose of absorbing the sulpho-carbons—*i.e.*, the sulphur in other forms than sulphuretted hydrogen. A second purifier should be used containing fresh lime or oxide of iron to arrest any sulphur compounds passing forward from the previous vessel containing the sulphides of calcium. When the first purifier has become saturated to such an extent as to be no longer capable of efficiently absorbing the sulpho-carbons, it is to be charged anew with fresh sulphide of calcium. The easiest and most economical manner of making or producing the sulphide of calcium to any required extent is described *infra*, section 2. It is not indispensable that the whole of the carbonic acid, or of the sulphuretted hydrogen, shall be eliminated from the gas before it enters these sulphide of calcium purifiers, but the less carbonic acid and sulphuretted hydrogen enters the said purifiers, the longer will their contents remain in an efficient condition for purifying the gas from sulphur in other forms than sulphuretted hydrogen. When the gas has previously been completely purified from carbonic acid, and from sulphuretted hydrogen, the contents of the sulphide of calcium purifiers will remain efficient for a long time, seeing that the only "fouling" element which enters is the small amount of sulphur which exists in the gas in other forms than sulphuretted hydrogen. "The claim based upon that is—Firstly, the employment of sulphides of calcium in separate purifiers as a means of purifying coal gas from sulphur existing in other forms than that of sulphuretted hydrogen."

There is really in this nothing but the enunciation of a chemical truth that pure sulphides of calcium will absorb the sulpho-carbons. The plaintiff believed that he had discovered that chemical truth, which is referred to in the referees report as a discovery, although it had been taught for many years in many books, and was well known to chemists. There is no invention of any particular process or means of employing the pure sulphide of calcium. If pure sulphide of calcium is to be used, it must be used in some separate holder of it, and the thing holding it would be a separate purifier; and there is nothing, therefore, in any previous part of the specification to limit the universality of the claim to the employment of sulphides of calcium for the removal of sulphur other than sulphuretted hydrogen. It is obviously impossible to suppose such a claim as that which was plainly based on the plaintiff's mistaken idea that he had discovered that peculiar property in sulphide of calcium.

Passing over for the moment the second claim, which has been the principal subject of controversy both in evidence and in argument, the defendants challenge absolutely the novelty and utility of the other three. The plaintiff so challenged has failed to produce any evidence that they are of the slightest value. The defendants evidence is, in general terms, that they have been treated, tried, and

abandoned. The 57th paragraph of the plaintiff's first affidavit says: "With regard to the processes described in my specification (other than the sulphide of calcium and lime process therein, in Sections I. and II. described), the novelty of which other processes is denied by the defendants"—I observe he says "denied," but he does not mention that their practical utility is also denied—"the novelty of which other processes is denied by the defendants, I say that such other processes are, as regards the chemical actions thereby taken advantage of, precisely analogous to the sulphide of calcium process, and I say most positively that, prior to the date of my letters patent, no such process had been invented, or was known. Up to the present time, I am not aware that the said other processes have been tried at gas-works, but, speaking to the best of my knowledge and belief, I say that I have no doubt they will be found as efficient for the purpose of sulphur purification as the sulphide of calcium and lime processes are proved to be." The concluding portion of Mr. Thomas Stevenson's affidavit (paragraph 8) says: "Speaking to the best of my knowledge, information, and belief, I say that the plaintiff's invention is novel and highly ingenious, and I believe that the lime process mentioned in the specification has been found at the defendants works at Beckton to be highly efficacious; and, speaking from my knowledge of chemistry and chemical analogies, I entertain no doubt that the other processes although I am not aware that they have been tried on a manufacturing scale—would upon trial prove to be equally effective." The last paragraph of Dr. Heisch's second affidavit, which was an affidavit in reply, after reading and considering the defendants evidence is: "I still consider that the plaintiff's processes are novel, valuable, and efficient," and the last paragraph in Mr. Harry Edward Jones's affidavit is this: "Mr. Patterson's invention as applied to soda and ammonia has not, so far as I am aware, been tried on a manufacturing scale, but as in these processes the same chemical affinities are relied upon, and the same chemical actions come into play, I believe the said processes will be found as efficient as the plaintiff's lime process has been found to be." That is the whole of the evidence on the subject, and those paragraphs, which are substantially the evidence on the subject, are utterly valueless as evidence of novelty or utility. They have not even been tried by the plaintiff or any of his witnesses even experimentally in a laboratory or with models. The one experiment made by the plaintiff, showing that a mixture of sulphur and sawdust in a tumbler removed a certain quantity of sulphur from the gas supplied to the office, is evidence of that chemical fact, but not evidence that the fact is of the slightest practical utility. The plaintiff has in our judgment wholly failed to prove either the novelty or utility of anything claimed under any of the three last heads.

The great controversy, however, of fact and argument, as before stated, has relation to the second head of claim, which is called "New Principle and Process of Employing Lime Purifiers. At present the action of lime purifiers is greatly impaired, owing to the carbonic acid in the gas which enters them, whereby the lime in those vessels is converted into carbonate of lime, which does not absorb sulphur in any form. Indeed (as the principle for employing lime purifiers, now described, has not hitherto been known or applied) in gas-works where oxide of iron purifiers are used after the lime purifiers, the contents of these last-named vessels, under the present mode of working them, sometimes exist almost entirely in the form of carbonate of lime, the lime having become desulphuretted by the carbonic acid in the gas, and the sulphur compounds driven forward into the subsequent oxide of iron purifiers. Under this patent I propose to eliminate carbonic acid from the gas in such manner that in any required number of the said purifiers the lime shall be converted into and (so far as required) maintained in the form of sulphides of calcium. And in doing so I turn to account the superior affinity which carbonic acid has for lime, for soda, for potash, and for ammonia, compared with sulphuretted hydrogen. One process of applying the above described principle is by passing the gas through the first lime purifier or purifiers of the series, for such time that the carbonic acid, from its greater affinity for lime, shall have expelled sulphuretted hydrogen from the said purifier or purifiers, taking its place, and driving it (namely the sulphuretted hydrogen) forward into the succeeding purifiers. By this means the carbonic acid can be wholly eliminated from the gas by the first purifier or purifiers, while sulphuretted hydrogen being driven forward, converts the contents of the succeeding purifier or purifiers into sulphide of calcium, which is a highly efficient material for purifying the gas from sulphur in other forms than sulphuretted hydrogen. Thereupon, these latter-mentioned purifiers, now containing sulphides of calcium, may be used first in the series, and the gas passed through them into subsequent purifiers containing fresh lime, whereby the contents of these subsequent purifiers, or any of them, can be converted in turn into sulphides of calcium. Or the first purifier or purifiers of the series may be constantly employed, chiefly for the purpose of eliminating the carbonic acid from the gas, while sulphur in all forms is eliminated from the gas in the succeeding purifiers." Then he says that he has been the first to discover the importance of carrying "into effect the principle of excluding carbonic acid from lime purifiers, or from any required number of these vessels, as a means of obtaining steady and perfect results in the purification of gas from sulphur. And, in applying this principle, I have also been the first to turn to account and practically apply the greater affinity which carbonic acid has for lime, for soda, for potash, and for ammonia, than sulphuretted hydrogen has." And the claim upon that is, "A method or system of employing lime purifiers in the manner hereinbefore described, whereby the contents of all the said purifiers, or of any required number of them, can be converted into sulphides of calcium, and also (if required) be maintained in that condition." There is in that no suggestion of any new apparatus—of any new process. There is no device or scheme of any kind. Lime purifiers in succession were in general, almost universal, use, wherever lime could be freely used. That is to say, the gas entered one, passed from that to another, and then generally, or sometimes, to a third. The gas, partly purified in the washers or scrubbers, passed through a series of lime purifiers into an oxide of iron purifier. That was the process before, and that is to remain the process after, and under the plaintiff's patent. What he claims to have discovered is, that if the carbonic acid, which is the first thing taken up by the lime, is not wholly taken up at the beginning, and is allowed to enter the last purifier or purifiers, it, in fact, poisons the latter, decomposes the sulphide of calcium already formed, disengages the other sulphurs absorbed by the sulphide, and, of course, fills the gas again with the sulphur impurities which had been removed. This is, indeed, a very valuable working caution and direction, but it is impossible to make anything other of it than a working caution and direction. It really amounts to nothing more than a direction to be sufficiently liberal in the use of caustic lime in the first stage, and an instruction that the moment it is so far carbonated as not to arrest the carbonic acid, it should be removed, and a fresh supply of lime got. It may be a direction, an instruction of the greatest possible value and utility, but it is utterly impossible to make such a direction and instruction, however valuable, the subject of a patent. It does not differ in principle, although it does differ enormously in scale from a cook's instruction and direction as to the best means of manipulating articles of food. How could an infringement of such a patent be predicated? Would it do to say in the days of your uninstructed ignorance you allowed the lime to remain three or four days? Now that I have taught you better, you remove it in every 48 hours? Could the court say in words (and, if not in words, could it in effect say) we restrain you from working your lime purifying process in any such way as will not allow the carbonic acid to enter the last purifier in sufficient quantity to do substantial mischief, or in less quantity, on an average, than it used to do in former times, on an average. No one has a right to prevent a workman from using care and keeping his tools in the most efficient state. No one has a right to prevent a manufacturer from cleansing his vessels, and throwing away the useless contents whenever he likes, or to ask him his motives or intention in doing so.

Besides this, however, the defendants insist that what they are doing now, and which is alleged to be the infringement of the patent at the Beckton works, they were doing at those works before the date of the patent, and that what they are doing at the Bow works they had been doing for years. The evidence on this subject on the part of the defendants is absolutely overwhelming. It is direct, positive, and unequivocal, and, if false, it must be wilfully false and perjured within the knowledge of scores of persons; and against this there is merely the speculative conclusion which is derived from results. The plaintiff says, up to a certain time before you knew of my process, as described in the referees report, you failed to purify your gas properly. Since you became acquainted with my process you have purified your gas effectually; the conclusion is inevitable that you have made some change, and, as you are now confessedly using my process, you must have been using something not my process before, and your evidence to the contrary must be disregarded. We cannot so deal with such a body of witnesses and such a mass of evidence, including unmistakable documentary evidence which was in existence before the date of the letters patent. On the 15th of February, 1872, the plaintiff writes to Mr. Trewby as follows:—"My dear Sir,—As CO_2 (carbonic acid) has a greater affinity for lime than SH_2 (sulphuretted hydrogen) has, it may be confidently expected that a tray of clean lime will take out CO_2 in greater proportion than it takes out SH_2; in this way the relative amount of the two elements may be altered, so as to bring down the CO_2 in greater proportion—say, instead of CO_2=4 and SH_2=2, we might have CO_2=2·5 and SH_2=1·5. This, of course, would greatly improve the action of the lime purification. This might be tried experimentally by passing the gas from the scrubbers through a tray of clean lime, and testing to see the CO_2 and SH_2 in the gas both before and after. Or, perhaps (you can judge), you might pass all your gas in each purifying-house through one purifier first, and change the lime in this one quickly, as the back pressure shows it turned into carbonate, or else as soon as it gets foul.—Faithfully yours, R. H. PATTERSON.' And, on the 19th, Mr. Trewby writes as follows:—"I may add that within the last few days I have been working the lime purifiers in a somewhat different manner; that is to say, I have kept certain purifiers for the purpose of taking out the carbonic acid only, and the remainder for the sulphur. I am in hopes that this will do good." Mr. Trewby swears, and there is not the slightest reason to doubt his evidence, that what is stated in that letter is according to the fact, and if that be so there was a clear prior user. The letter contains, moreover, a clear anticipation of the exact principle which the plaintiff claims to have been the first discoverer of. Dr. Letheby swears that on the 11th of March, when he visited the works at Beckton, and found that the company were working four purifiers in a set, the first two being for carbonic acid, and the last two for sulphur, and when the first vessel, or purifier, showed an effluent with carbonic acid, it was changed, and the succeeding purifier brought into action, and so on for the series, and the date of his visit and what was shown him' on that day, are conclusively corroborated, if they required corroboration, by Mr. Evans's diary of that date. It is possible that what Mr. Trewby said and did on the 19th, and a few days before, may be accounted for by what the plaintiff says in his letter of March 27, 1872:—"All the suggestions in the report have been communicated to Mr. Trewby and others months ago."

We are satisfied that Mr. Trewby's evidence is true, and Mr. Trewby's letter is genuine. We are satisfied that Dr. Letheby's evidence is true, and that Mr. Evans's diary is genuine. We do not think it necessary to go any further into the details of the evidence whether the defendants have sufficiently accounted for the difference in the results produced in different parts of the year 1872, or what was or were the cause or causes of such difference, and open a field of speculation into which we are not called upon to enter. It cannot affect the fact (as to which there is no legitimate ground for doubt) that prior to and on the 9th of March, the process described in the plaintiff's specification was in actual use and work at Beckton, and that a process, in principle and substance the same, was in actual use and work at Bow. It is possible, and indeed probable, that the company became more liberal in the supply, and the manager more careful in the use of the lime, but that is in our judgment wholly immaterial. The plaintiff's case has, in our judgment wholly failed, and his bill must be dismissed with costs, including the costs of the appeal.

HIGH COURT OF JUSTICE—QUEEN'S BENCH DIVISION.

WESTMINSTER, MONDAY, MAY 15.

(*Before Justice* BLACKBURN *and a Special Jury.*)

SUGG *v.* SILBER.

Mr. WATKIN WILLIAMS, Q.C., Mr. CAVE, Q.C., and Mr. WEBSTER were counsel for the plaintiff; Mr. ASTON, Q.C., Mr. HARRISON, and Mr. MACRORY were counsel for the defendant.

Mr. WATKIN WILLIAMS, in stating the plaintiff's case to the jury, said that the plaintiff, Mr. Sugg, was a gas engineer and a gas burner and apparatus manufacturer in Vincent Street, Westminster. The defendant, Mr. Silber, was also a gas-burner manufacturer, and was better known probably in connexion with a lamp known by the name of the Silber lamp. The action was brought by the plaintiff for the infringement of a patent granted to him for improvement in gas-burners. Mr. Sugg succeeded his father, and had been engaged in the manufacture of gas-burners and gas apparatus from boyhood down to the present time. He was an Associate of the Institution of Civil Engineers, and honorary member of the British Association of Gas Managers, and he had designed and made gas-burning apparatus for all the principal cities where gas was burned throughout the world, and he had also supplied gas-burners to the Houses of Parliament and other great institutions. Mr. Silber, the defendant, was not a practical man, but was one of those clever gentlemen who might be met with occasionally, who were exceedingly skilful in appropriating the brains of other people, and in pirating—if he might so use the word, because that was the charge in this case—the invention of Mr. Sugg. The invention, which had cost Mr. Sugg years of labour, and diligence, and industry, had been made the subject of one of the coolest piracies that had ever been heard of in a court of justice, not only injuring Mr. Sugg in his business, by taking from him his invention, but also imposing on the public, pretending that he, and not Mr. Sugg, was the real designer.

Justice BLACKBURN: I see there are two separate counts.

Mr. WILLIAMS said he would only trouble the jury with the first one, and the reason for this would appear in the progress of the case. In order to give the jury a clear idea of the nature of the patent, it would be necessary for him to give a slight sketch of the condition in which gas-burners and the consumption of gas was at the time before Mr. Sugg made the improvement. Previous to 1858 there were, and still are, for the consumption of gas, two distinct kinds of burners—namely, the flat-flame burners, with one flow of gas through them in various shapes, and the other a circular burner, in the form that is known as the Argand burner, where the flame is annular, or cylindrical. With regard to the Argand burner, in the early time of gas lighting there were no such things as meters in existence, and the plan adopted by the gas companies and by gas consumers for the purpose of ascertaining the quantity of gas consumed was by means of regulating the number of holes in the top of the burner. The old burner was a sort of round box with a flat top, and holes pricked in the top, so that the gas entered the circular chamber, and found its way to these holes, which, in the early time of gas-burning, averaged from 10 to 15 up to 30; but the 15-holed burners were considered to be a sort of medium burner for the consumption of 5 cubic feet of gas per hour. At this early period of gas-burning, it was the impression, and still continued to be the belief of gas companies and those skilled in gas, that the smaller these holes were, the better for the complete consumption of the gas, and the most perfect production of light; the idea being that the finer and smaller the jet of gas that came out, the more

complete was the combustion, and the more complete was the illuminating power. In 1858 the diameter of these holes was the 1-100th part of an inch, which was considered the best size. The system of meters was introduced, and, to some extent, necessity arose for regulating the precise size of these holes. Mr. Sugg, who had been brought up in his father's factory, and who was a practical and intelligent man himself, and acquainted with the chemical materials of combustion, made a number of experiments, in order to see whether he could not improve the gas-burners, having an impression and belief that the gas was not entirely consumed; because, in the old days of gas-burners—and he was afraid now, with imperfect burners—it became obvious to anybody that there must be some scheme for testing the illuminating power of gas. Accordingly, a great number of experiments were made, and a number of burners were purchased from various makers, and experiments were also made with Mr. Sugg's own burners, resulting in the invention which he had since patented. He found that in a number of burners the little holes in the iron top were apt to be choked up, which blocked the egress of the gas, and that it has been the practice of manufacturers of gas-burners, and gas-fitters, to clean these burners with a broach or little pin, one of the effects of this being to enlarge the size of the holes, and to make the size of them very irregular. Mr. Sugg observed that with regard to some of the old burners that had been cleaned a good many times with the broach, the holes had been considerably enlarged, and he discovered also, contrary to expectation, and contrary to the received opinion of persons skilled in gas, that when the holes were made larger, the illuminating power of the gas was greatly improved. He also believed that one of the advantages of these holes being larger, and one of the causes of the improved illumination by reason of this, was due to the circumstance that the gas issued from the burner at a less velocity with a large hole than with a very fine hole. That was his impression; but at that time it was not more than an impression, because it was a matter extremely difficult to make experiments upon. He then prosecuted his experiments further. He (the learned counsel) might mention this in passing, that the illuminating power of the gas, or the illuminating capability of gas, depended upon the contents of the gas, and, therefore, upon the quantity of carbon it contained. Consequently, if a cubic foot of gas contained a certain number of grains of carbon, say 500 grains, it could easily be understood that if by any cause that cubic foot was extended into two cubic feet, of course the gas became diluted, and instead of 500 grains to the cubic foot, there would only be 250 grains. If the volume was increased by intermixture with air, or by mere expansion of gas, the illuminating power of the gas was diminished. That being present to Mr. Sugg's mind, he directed his attention to improving the burners; and he also took into his counsels with him the late Dr. Letheby, whose death was a sad loss to Mr. Sugg in many ways, as it had prevented his now being called as a witness in this case. Afterwards, a number of experiments were made, and they devised a burner which went by the name of the "Sugg-Letheby" burner, and for the first time they introduced, instead of these small holes of 1-100th of an inch in diameter, a hole of 5-100ths of an inch in diameter, making in a sense, a complete revolution in the gas-burner, and going in direct opposition to the received opinions of all experienced persons up to that time. In addition to that they also added another great improvement—namely, that in place of having these holes pierced in the metal, at the top of the annular chamber, they put on a top of steatite which was something in the nature of lava, and was manufactured in Germany. This substance was not capable of corrosion, so that it would not be required to be cleaned, and the holes would be made uniform in size and perfectly even, thus there would be no irregularity with regard to them. That constituted the Sugg-Letheby burner. This burner by degrees having been introduced in 1859 or 1860, continued for eight or nine years gradually to increase in reputation, until about the time when the particular invention was introduced to which he (the learned counsel) would call the particular attention of the jury. It was the universally accepted burner all over the world. This enlargement of the holes, and this steatite top, proved to be an unquestionable step in advance. In 1869 the Sugg-Letheby burner was adopted by all the great companies and gas referees; and the gas of all the companies in London, Birmingham, Manchester, Paris, and all over the world, was tested by this burner. It was never patented; and it would be found that this fact was most material in considering the case. There were reasons for not doing so, which would be quite apparent to the jury before the case was over. Although there was an improvement, they were still, owing to the difficulty of understanding the chemical operation of these burners, in a state of uncertainty as to what the annual state of advance was due to. The improvement was equal to two candles, [The learned counsel then proceeded to detail the method by which the illuminating power was tested.] Mr. Sugg went on to continue his experiments from the time of the introduction of the Sugg-Letheby burner to the time of his taking out the patent in 1869. He discovered that there was no doubt as to his original impression, that the increased velocity of the gas was injurious both to the illuminating power per cubic foot consumed, and also detrimental in other respects, by permitting unconsumed gas to pass away, and that it was also injurious to persons in the room. The increased velocity of gas was a matter to be dealt with; and he set to work to reduce the velocity down to the lowest possible point which could be obtained. In the case of a flat-flame burner, it was impossible to reduce the pressure and the velocity of the gas, because it was an essential condition of that burner that there should be a certain pressure and velocity to throw the gas out of the burner and spread it into a flame, so that with a flat-flame burner Mr. Sugg could not accomplish what he had in his mind. But with the Argand burner there was no such difficulty. The experiments which Mr. Sugg made showed him that there was no practical difficulty in reducing the velocity of the gas down to nothing, and to a point where there would be absolutely no pressure at all. Another thing he discovered was that, in consequence of the enormous heat which was unnecessarily generated in the combustion of gas for the purpose of producing the illumination necessary, decomposition took place, and illumination did not follow. There was an immense deal of heat produced at the point of combustion. That heat, with the old burners, one could naturally understand—the burner being a very great conductor of heat—would be produced at the burning point, pass down the apparatus, and would thus raise in the whole affair a tremendous temperature. The result of that was twofold. It increased the volume of the gas inside, so that if there were two or three cubic inches of gas contained in the chamber, the enormous heat of the chamber would double the volume of the gas, the effect of which would be to reduce the per centage of carbon to such an extent as to reduce the illuminating power in the volume of gas issuing from the jet. Consequently, the great heat and the expansion of the gas had a directly bad effect on the illuminating power. Mr. Sugg, as had been stated, made experiments extending from 1859 down to 1869, during which time he manufactured and sold thousands and thousands of these burners. He endeavoured to reduce the velocity and the temperature of the gas, and to regulate the quantity and the pressure of the gas at the entrance of what was called the gas-chamber, where the gas was collected immediately on emerging from the tubes.

Justice BLACKBURN: Is this the patent?

Mr. WILLIAMS said that it was. The peculiarity of the burner was that the holes from which the gas issued should bear such a proportion to the apertures at the consuming point, as that there should be less space for the gas to come in than there was for it to go out. Supposing there were thirty holes, and each of them was 5-100ths of an inch in diameter, those circular holes would be larger in the aggregate area than the area of the inner pipes by which the gas entered the gas-chamber; so that there could be no possible rush of gas through these holes. Another peculiarity was that the chamber in which these holes were perforated, instead of being made of metal, was made of steatite, which was incorrodible, and which was also a bad conductor of heat. The effect of that chamber would be to prevent the communication of heat from the point of combustion to the burner, and this would do away with that expansion of gas in the chamber which gave rise to the bad consequences that had been before mentioned. The gas was conveyed to the chamber by a certain number of tubes made of steel, copper, or brass, the size of which was exactly calculated to be of the same area as the inlet-tube. At any rate, they were to be of such a fixed area as would regulate the quantity of gas. It was said that gas corroded those metals, but that was not the case. Any corrosion that took place was in consequence of water or damp caused by the consumption of the gas coming in contact with the pipes. An iron-nosed burner would corrode where combustion took place; but with those porcelain or steatite chambers no corrosion could take place. The second part of the chamber was composed of tubes of a fixed size and area, which would be regulated according to the quantity of gas sought to be introduced into the chamber. The third contrivance was that there should be an inverted cone where the three little tubes ran away from the centre of the gas tube, coming down to the throat of the pipe. Then the nose-piece would run up to the cone, so that if it were screwed right up it would shut the channel up altogether, so that no gas could pass. This would give the operator complete control over the quantity of gas that passed at that point into the three tubes, through them on into the gas-chamber, and thence to the point of combustion. It would also be observed from the diagrams that at the point where the little nose-piece screwed on there were some paper washers, which were placed round the neck of the screw, the object of them being this, that when the screw was being adjusted and the burner had to be tested, the gas passed through it, and when it was desirable to regulate the exact quantity of gas that had to pass through the burner, a number of paper washers were put in and adjusted to the exact point, in order to produce the effect he had explained. The burner for which the patent was obtained acquired the name, in the trade, of the "London" burner, and he would mention, as a remarkable fact in regard to this patent, that before the Act of 1868 was passed there were a great many investigations by parliamentary committees, and inquiries as to whether the gas companies were supplying gas of a proper illuminating power. Under that Act official referees were appointed, whose duty it was to examine into the best burner that could be obtained, for the purpose of testing the gas supplied by all the gas companies, and then to fix upon a standard. Almost all the gas-burners that could be produced were examined both by the Gas Referees and the Metropolitan Board of Works and the Corporation of the City of London. The most minute and searching examination of testing was made, and a unanimous decision was come to by all these scientific persons to adopt Mr. Sugg's "London" burner as the standard burner. Mr. Sugg succeeded by this burner in raising the illuminating power of gas from 12 candles to 18 candles, and this could be proved from the mouths of gentlemen whose knowledge on this subject was beyond doubt. From 1869 down to 1873 the burner got into gradual use and reputation, and was adopted not only by the Metropolitan Board of Works and by the Corporation of London, but also by the Trinity House, and by all the great gas-consuming companies all over the world, down to the year when Mr. Silber pirated and copied it—he would not say imitated, because he was not entitled to the word "imitated"—but copied it in the most shameless manner. What happened was this. Mr. Silber was supplying some lamps to the Trinity House in the beginning of 1873. At that time the authorities at the Trinity House were anxious to apply Mr. Sugg's "London" burner to some particular lighthouses, but they discovered that the flame was a little too long for the lens, and they wanted, if possible, to produce such a modification of the "London" burner, retaining all the benefits and improvements of it, as would bring the light into the focus of their lenses. Accordingly, they procured one of the "London" burners, and a great many experiments were made between January and June, 1873, and at last, by a simple contrivance, the flame was reduced to the exact point which was requisite for the purposes of the lighthouses. It so happened that at this very time some persons connected with Mr. Silber were also at the Trinity House, and shortly after Mr. Sugg completed the Trinity burner, which was a modification of the "London" burner. But to his great astonishment he found that Mr. Silber had manufactured a burner which was pirated all over London; and while Mr. Sugg was quietly manufacturing his burners, and sending them all over the world, he found that there were lectures being given upon the properties of the Silber burner. Mr. Sugg naturally took alarm at this, and examined it, and what was his astonishment, when, on looking at one of those burners of Mr. Silber's, he found that it was the same as the Trinity burner in every single particular, in fact, was almost a slavish copy even of some details which were immaterial. But there was this remarkable thing about it, which was a small affair in itself, but which showed that Mr. Silber's burner was an infringement of Mr. Sugg's patent. Mr. Sugg was probably one of the largest manufacturers of these burners in the world, and he alone, the learned counsel was informed, had these burners made of a great number of sizes, and he was the only one who indicated the sizes of these burners by a letter. He had them marked with letters of the alphabet from the letter A up to M, and it was a most extraordinary thing, that when Mr. Silber's burner came to be manufactured, and to be sold to the public, he marked it with the letter G, which used to be the mark of Mr. Sugg's Trinity burner. Possibly, some one had been employed to make a drawing of the burner, and copied the letter G without knowing the import of it. In Mr. Sugg's burners also there were three little arms that projected to hold the glass. These arms were triangular; but their triangularity was an utterly immaterial thing altogether. It arose from the fact that Mr. Sugg cast them in metal, and, by a mere accident, it became necessary to make the triangular form, in order to keep them from dropping out of the mould. Mr. Silber had copied the triangularity of those arms, although they were made separately and soldered on, and not cast with the whole, but this fact the person copying Mr. Sugg's Trinity burner was not probably aware of. It so happened also that the size of the glass which was placed on Mr. Silber's burner was exactly the same to a decimal point as that of Mr. Sugg's; so that in all the essential points connected with the shape and material, they were exactly similar. The main question the jury had to try was whether this was an infringement or not, and he thought that he had said enough to lead them to follow the evidence, and to show that this was not only an infringement; but a shameful infringement. Mr. Silber had no pretensions to ingenuity or experience, but this was an attempt, on his part, to rob Mr. Sugg of his invention, and to go before the public pretending that he was the discoverer of it. The reason why the second count was not introduced was this. It would be observed that a part of the combination and mode of Mr. Sugg's plan was the inverted cone, and the little nose-piece that regulated the supply of gas. That had been imitated in Mr. Silber's burner, not in the exact form of the inverted cone, but he had imitated that which was an equivalent for it, and which was an improvement upon it, contained in another patent of Mr. Sugg's. In place of having the inverted cone downwards, and the screw going up to close it, Mr. Silber had an erect cone lower down, the cone itself being attached to a screw and passing into the pipe, and if the cone were screwed right up, the pipe would be closed. Then the gas was introduced into the gas channel in this way—the cone was hollow, and the gas entered at the lower portion of the cone, and then in the centre of the cone there were three or four orifices opening into an enlargement of the pipe, so the gas had to enter the cone through the holes at the side, and would pass through the cone and upwards, and then, by screwing the cone up or down, it could be converted into a tap, and as the cone was raised or lowered, the supply of gas would be regu-

lated. And not only did it regulate the quantity of gas, but by making the gas pass through the centre cone into four holes, it distributed the gas all round the cone, so as to make a more even distribution of it in the gas-pipe. That was supposed to have an improved effect upon the gas, but it still left the cone as a regulating tap with the same operation exactly as the inverted cone of Mr. Sugg's burner. As this was copied from another patent of Mr. Sugg he did not think it proper to trouble his lordship or the jury with it, but he was obliged to refer to it in order to explain how Mr. Silber had infringed the patent of 1869. The defendant to the action, as far as he knew, raised every imaginable objection, and pleaded everything that could be pleaded; but his impression was that the defences were reduced to three. In the first place, that this was not an infringement at all, and if he failed in that, he would say that Mr. Sugg was not the personal inventor of the patent, and that other persons had invented it before him. He had handed in a list of 20 patents

Justice BLACKBURN: There are certain things which, if we could get at, would make the question simple enough. The one is, first of all, what is the invention here claimed; whether that invention has been adopted by the other; and, if we once know that, it is easy to see whether there is an infringement or not. Then as to the validity of the invention. When we once ascertain what the invention is that is claimed, then comes the question how much or any part of it is new. The first grand matter in all these cases is what is the invention.

Mr. ASTON: If my friend had told me that, I should have saved him some trouble.

Mr. WILLIAMS said he endeavoured to explain what was the state and condition of the burners, and the common knowledge respecting burners at the time the patent of 1869 was taken out, and then he claimed, on behalf of Mr. Sugg, improvement in the manufacture of these gas-burners by those combinations which he had explained. One thing was certain—that no single burner except Mr. Sugg's could accomplish the same result of increasing the illuminating power from 12 to 18 candles. The three main points of defence were, first of all, that this was not an infringement; secondly, that Mr. Sugg was not the true inventor; and, thirdly, that supposing he had been the inventor, and supposing the defendant had been the infringer, the specification was bad, because the plaintiff did not sufficiently indicate what his invention was, or how it was to be carried out; but he (the learned counsel) would call witnesses who would prove the contrary.

Mr. *William Thomas Sugg*, examined by Mr. CAVE.

I am the plaintiff in this action, and carry on works at Vincent Street, Westminster. The business was carried on by my father before me, and I have been engaged all my life in the manufacture of gas-burners. I have particularly devoted my attention to the question of Argand burners. An Argand burner is used to burn gas with the chimney, and you can burn the gas with no pressure at all at the point of ignition, as I do. The flat-flame burner is never used with a chimney, and it mostly requires a pressure of about 2-10ths of an inch to blow the flame out in its shape. There are two kinds of flat-flame burners, generally called the fishtail, where there are two little impinging flames one against the other; the other being what is commonly called the bat's-wing, with a cylinder on the top and a slit cut across it. The lowest pressure you can get a flat-flame burner to blow out a flame with is about 2-10ths of an inch of water when it has got a pressure upon the point of combustion. Then it flashes out into a shoot of flame. I mean by that a column of water 2-10ths of an inch high. Before 1858 most of the Argand burners in use were perforated with small holes through a cast-iron or wrought-iron top. This was always used for testing gas, and, generally speaking, those burners, if used for testing gas, were considered to be the best of their kind at that time. Originally gas consumers burned gas without any meters at all, and they used to pay according to the number of holes they had in their burners. The diameter of the holes was about the 100th of an inch. They were always drilled with a very fine needle, and, after they were drilled, it was necessary to open them out or to regulate the shape of the flames, and make them burn nicely and evenly on the top, and they were always regulated to the 100th of an inch. I have brought out many thousands of them. It was evident, from the fact of the gas being supplied by contract, that it was absolutely necessary to the gas interest that the size of the holes in the burners should never be more then the 100th of an inch, because if they were larger they would pass more gas per hour, and, therefore, the contract between the company and the consumer would be altered in consequence. The gas-chamber was composed of iron or brass. [Witness minutely explained the details of the gas-chamber to the jury.] There was a common tendency on the part of consumers to clean out the holes with a pin, and the consequence was that the holes became enlarged, and the gas company would not supply gas to burners like those, and the old tops were taken out and new tops put in, pierced with the 100th of an inch holes. The gas issued from the burners with considerable velocity. In the old burners I estimate that the velocity might vary. When they were new the velocity must have been something like 90 miles an hour, and when they got worn out a little, it came down to 60; or about from 80 to 132 feet per second. Some little time before 1858 I turned my attention to the question of these Argand burners, and experimented upon a number of them with regard to the amount of light produced by them. I was engaged in making photometric apparatus at that time, and I found there were great differences in the observations by scientific men, such as Dr. Cooper and Dr. Brand, who met with great difficulties in estimating the illuminating power of the gas. I thought the difficulties were not caused by any defect in their instruments, because I found they were pretty much alike, but I thought the difference was due to the burners. That caused me to examine into these burners, and I found, to my astonishment, a great difference of illuminating power in these standard burners. It was generally supposed by scientific men then—and I think is now by a great number of people—that all burners are alike, and that if you burn the same quantity of gas you will get the same illuminating power out of it; but I found that was not the case. The difference was very considerable—something like from 7 to 12 candles. I found that a burner burning 5 cubic feet of gas would give a light equal to 7 wax or sperm candles. Another one gave a light equal to 12 of those candles; but they all averaged between 7 and 12. Finally I found that some of them had got larger holes than others—they had been nearly worn out. Others were new, and had very small holes. I found that those that had the largest holes gave the best result, and from that I was induced to examine into the circumstance of what size the holes should be drilled. When a hole reached a certain size, it had been customary to condemn the burner. I found the worn-out holes were very irregular in their flame; but they gave the best light. In consequence of this discovery I made a burner with large holes, first, in conjunction with Dr. Letheby, in 1858; and into that, instead of using the usual iron or metal top, I put a piece of steatite, drilled through with very large holes. Steatite is a material that is found somewhere in Germany, and in a soft state, like ivory; but you can turn and drill it, and make anything out of it, in the same manner as you would make a meerschaum pipe. After you have it all drilled properly, it can be burnt to a very high temperature, and becomes as hard as the hardest steel. I had some tops made in Germany, with holes 5-100ths of an inch in diameter. I put these into the top of this kind of burner, and then made what was afterwards adopted and used as a standard burner, because it was found to be a very good burner—I believe, at that time, better than any other burner that was in existence. It was called Sugg's 12-candle standard burner, and was brought out in 1858. I continued my investigations, and was assisted in them by Dr. Letheby, with whom, in 1860, I became associated in the matter of making a standard burner for testing the illuminating power of the gas supplied to the City of London. He and I succeeded in producing a modification of the 12-candle burner, which was adopted by the Corporation for testing the gas supplied to the City. This burner was found to be the best of its kind at that time, and was adopted as a standard burner very nearly all over the world for testing the illuminating power of gas. It was also largely adopted by consumers. It had holes of 1-500th of an inch in diameter, and had a steatite top to the gas-chamber. For the first time in Acts of Parliament relating to gas, they stated the definition of the Letheby burner, and the size of the holes on the top. The bottom of the crutch of the Sugg-Letheby burner screws on to the pipe. It is below the gas-chamber. The gas passes from the pipe into the burner; it passes through the crutch, or in two streams, to deliver the gas into the gas-chamber. The cock is below the crutch which turns on the gas, and the gas arriving in the gas-chamber would pass through the holes in the steatite top and be consumed. The diameter of the holes was 1-500th of an inch, but they did not bear any relation to the tubes of the crutch through which the gas passed. After the gas passed the tap, there was nothing to impede its progress till it came to the steatite holes. By increasing the holes, I brought the pressure down to about six miles per hour, or about 8 feet per second. That considerably improved the illuminating power. The burner gave about 2 candles more than the average burners used by consumers. There was a considerable disadvantage attending the use of a metal gas-chamber. It became heated, and the gas was expanded in bulk, and I have always contended that this expansion reduces the illuminating power. This idea is not generally maintained. Previous to this time—from 1863 to 1869—all authorities upon gas-burners thought it necessary to heat the gas before it was ignited, in order to give the full illuminating power; and this burner did heat it. The heating of the gas increased the velocity; and in that burner the gas was doubled in bulk, and increased in velocity in the same proportion. In 1858, when I made my experiments, I believed that the heating of the gas was necessary to the proper illuminating power; but afterwards I came to the conclusion that keeping the gas as cool as possible, before igniting, was the right thing to do. Between 1863 and 1869 I continued my experiments in trying to reduce the velocity of the gas where it issued from the burner, and to keep it as cool as possible. Ultimately I succeeded in producing the "London" burner, which is the subject matter of the present patent. I retained the large holes at the top of the burner, in order to reduce the velocity. I also substituted three small tubes for the ordinary crutch. To get into the chamber the gas had to pass through three tubes, and in no other way. The total area of those tubes was made less than the total area of the holes at the top of the burner, so that the outlet of the gas was larger than the inlet. I also, with the view of reducing the velocity, fitted a nose-piece, which screws on to the bottom of the burner. It is kept from going up close to the top by paper washers. If there were no washers, the nose-piece would press against the cone, and very nearly prevent the passage of gas. Each washer so placed increases the area of the passage of the gas. The quantity of gas passing can be regulated by increasing or diminishing the number of these washers. The velocity by this means was decreased 1½ miles per hour. For the purpose of keeping the gas cool, I made the gas-chamber of steatite, instead of making it as before of brass or iron. Steatite is a bad conductor of heat, but brass is a very good one. I also put an air cone round the steatite chamber of Britannia metal, the same as is generally employed in making tea-pots. The gas-chamber was circular and hollow, which admitted of air passing all round it outside and inside. No air comes in contact with the gas till it comes out of the holes at the top of the burner. The air has a tendency to keep the gas-chamber cool, as does also the separating of the supply-tubes. These alterations affected considerable improvement in the illuminating power of the gas. It gave rather more than two candles more than the Sugg-Letheby burner gave with the same quantity of gas. I called it the "London" burner then, and do now; and I took out the patent for it, which was dated March 18, 1869. [The learned counsel then read the terms of specification contained in the patent.] From the description given in the specification, a person acquainted with gas-burners would be able to know what is described. My invention was successful. The metropolitan gas referees adopted it as a standard burner for testing gas, and it has since been adopted nearly all over the world, and is largely used by consumers. I have manufactured and sold a very large quantity, and the sale is now increasing. In 1872-3 I was applied to to make a gas-burner by the Trinity Board. My "London" burner was suited for their purpose, with the exception of the flame being too long for the focus of the lighthouse lanterns. I set to work to modify it. I was in the habit of marking the difference in the size of my burners by letters, from letter A to letter H. I believe that no other maker of Argand burner used letters for distinguishing the size; and I believe no maker ever made eight sizes. G is one of our sizes. They vary according to the number of holes. G size has 33 holes. A, the smallest size, has 15 holes, and gives a light of ten candles. G gives 25 candles, and was the size which they wished to use for the purposes of the Trinity Board. It was necessary to reduce the flame from 3¼ to 1¼ inch, and at the suggestion of Mr. Douglas, the engineer, I put on a cone used in one of their lamps and a sort of trumpet-shaped button, the effect of which was to reduce the flame from 3¼ inch down to 1¼ inch, and to give a more penetrating and intense flame. That fulfilled the requirements of the board. I also altered the shape of the inlet-pipes, in order to get them into the bottom of the burner. All the tubes are enclosed in a cylinder, and the burner is substantially the same as a "London" burner. The only difference is in the shape of the cone and the straightening of the tubes. I made 24 of these burners for the Trinity Board. Later on in 1874 I discovered the defendant using burners. I first saw one of them in the month of October or November of that year. I procured some of the defendant's burners. Burners marked Nos. 1, 2, and 3 [handed in] have been admitted, and have been opened. In the defendant's burner there is a steatite gas-chamber, exactly the same size as in my "London" burner marked G. It has large holes at the top for the exit of the gas. The air cone also resembles that of the burner which I made for the Trinity Board. The gas enters the burner until it meets an obstruction from a flat plate, and then it passes through certain notches into the gas-chamber. The total area of those notches is less than the area of the burner-holes. With regard to the velocity of the gas, the same effect is produced by these notches as by the tubes. The gas-chamber is circular and hollow, like the "London" burner, so that the air can pass all round and up the centre. In some of the defendant's burners I find at the base a part which serves the same office as the screw regulator at the end of the "London" burner. That produces the same effect of diminishing or increasing the supply of gas, just the same as is the case in the "London" burner when the number of paper washers is increased or diminished. The large holes in the Silber burner, and the regulation of the area for the admission of gas as compared with the exit of gas, are the same as would be produced by the Trinity "London" burner. On all the defendant's burners I have seen the letter G is stamped upon them, which is the same letter as I stamp upon the 33-hole burner. They produce the same quality, as well as the same quantity, of gas as the "London" burners.

Cross-examined by Mr. HARRISON: The method of construction which I claim to have invented is the same as described in my specification. The nose-piece, or inlet for the gas as far as the 3-8th, to screw on to the fittings, has been used, but never for the purpose of stopping the gas, by fitting into the cone-piece, except in the "London" burner. The upper part of the nozzle is new in so far as the regulation of the admission of the gas is accomplished by means of paper washers. The inverted cone, as an inverted cone, is new.

By His LORDSHIP: The mode of using the screw, so as to shut up the orifice of the burner and to regulate the gas, has never been applied to Argand burners before, nor, so far as I know, to anything else.

Cross-examination continued: The object of the improvement of all burners is to get the greatest illuminating power out the smallest possible quantity of gas. One of the main objects also of improvement in gas-burners has been to regulate the pressure, because the irregularity of pressure produces blowing. The first regulator that was ever used was a cone in an opening in a gasholder,

which shut or opened it as the gas was required. The cone has no doubt been used as a valve. The first gas-governor built by Clegg had a cone that acted in that manner. I do not know that such cones have been adjusted by screws. In Benjamin Lawrence and William Niblett's invention, there was a valve used, but not a conical valve; it was mushroom shaped. Being examined on the specifications of other inventions, witness said he did not think that the drawing of one of them showed a cone at all. Being shown another specification, he said there was no doubt a valve, but there was not a cone. He could close the hole by a half-ball plug instead of a cone. The specification said that the plug was to be adjusted by a screw, but it was not made in the same way as witness's burner. A good many valves for regulating the influx of fluids were conical valves adjusted by a screw. There was nothing new in their being used for some other purposes, such as steam or air, but there was something new in their being used in an Argand burner. Witness was then examined on Johnson's patent (1873), where he said there was no india-rubber plug, but an india-rubber washer of a conical form.

Some discussion ensued between the learned judge and the counsel as to the questions asked in cross-examination, when

His LORDSHIP expressed an opinion that, as it had been admitted that the use of conical plugs previous to 1863 for the regulation of matter through a pipe was not disputed, the questions asked by the learned counsel were not material.

Mr. HARRISON said he was wishing to show, by his cross-examination, that the witness was wrong when he said that the use of conical valves in regulating the passage of gas through a pipe was nothing new.

Witness was then further cross-examined upon various kinds of burners mentioned in the specifications of several patents, with the view of eliciting from him that there were several peculiarites of construction in those burners which resembled those of the "London" burner invented by him. He had never seen a burner before with three tubes. By using the three tubes he could get a more equal distribution of gas. He was not aware that any burners had been made of non-conducting material previous to his invention of 1869, except bat's-wing and fishtail burners, which had been made of steatite; but the majority of burners made at the present time were made from his models. He did not borrow the idea from Mr. Maximilian Felsenthal. He did not know that gentleman at all. He denied absolutely having bought any burners from him; he had no recollection of any transactions with him whatever. He made models in brass of the fishtail and bat's-wing burners previous to 1869, and had them sent over to Germany, where they were made in steatite.

By His LORDSHIP: The reason for their being made of steatite was because it was a non-corroding and non-conducting material, but principally because it was non-corroding. The non-conducting property was not known at that time.

Cross-examination continued: He had no recollection of buying any of the burners similar to that handed to him as having been purchased from Mr. Felsenthal. He had seen many of them before, and he supposed they were called Argand burners. They had porcelain gas-chambers. The steatite on the Sugg-Letheby burner extended about one-eighth of an inch down. He knew a maker named Leoni, but he never knew of his having made any gas-chambers of steatite or porcelain. He did not know what Adamas burners were. Adamas was an incombustible and incorrodible material, and was, no doubt, the same kind of thing as porcelain. He did not think Mr. Leoni brought out his Adamas burner previous to 1869. Shown Mr. Leoni's British Standard burner, witness said that it was the same as the Sugg-Letheby burner. It had a gas-chamber of adamas, and holes similar to the Sugg-Letheby. The notion of regulating the inflow of gas into the burner had never, he thought, been entertained by any one previous to 1869. Being cross-examined as to Durich's patent of 1856, he said the patentee only claimed to contract the gas-pipe below the flat-flame gas-burner, but there was no contraction in the burner itself for equalizing the flow of gas. The difference in the force of the gas by this arrangement would depend upon the kind of burner which was placed in the pipe. Durich's invention had the same effect on the inflow of the gas as if a burner were put on one end of a pipe where the gas was admitted, and a larger one at the end where the gas was to be burned. He denied that Williamson's patent of 1859 was a burner in which the whole area of the inlet was to be made less than the whole area of the outlet. Williamson's burner was a fishtail one, and the same remark as to the inflow of gas would apply to it as he had applied to Durich's invention. The difference between his (witness's) burner and Williamson's was, that the latter would require 6-10ths instead of 2-10ths pressure at the point of ignition. The difference between his Argand burner and Mr. Williamson's fishtail burner was that the illuminating power of the Argand was from 12 to 18 candles, and that he had so regulated the gas that there was no pressure at the point of ignition. Williamson put a smaller burner at the top than at the bottom of the gas-chamber. That was the only answer he could give as to whether Williamson's burner had a smaller outlet than inlet. Supposing there was a constant supply of gas through the pipe, there would not be an increase of velocity if the hole was reduced. With a certain size of hole and a high pressure from the mains, more gas would be forced through it; but if it was a lower pressure there would be less gas sent through it. As regards Argand burners, castings in soft metals were not new, but the mode of making the mould and casting was new. The mould was a novelty, because it cast in one piece what had hitherto been cast in separate pieces and soldered. Many burners had been cast in moulds since 1869, but he did not think any had been cast in soft metal. He had never made gas-burners in such moulds before 1869. He had cast a lamp governor in a metallic mould.

TUESDAY, MAY 16.

Mr. *Sugg* recalled, and re-examined by Mr. CAVE.

There is at different times an inequality of pressure of gas in the street mains. Several patents have been taken out for securing uniformity of pressure. The want of uniformity in a burner causes it to flare under a heavy pressure, and there is a considerable amount of waste in consequence. Regulators have been designed to obviate that inconvenience, and I myself have taken out patents for such regulators. The patents referred to yesterday have only in view the regulation of the pressure. There is not, in any one of those patents to which I was referred, any indication that the diminution of pressure would produce an increase of illuminating power. In order to produce a flame in a bat's-wing or fishtail burner, there must be a pressure of 2-10ths of an inch of a column of water. Mr. Williamson in his patent could not reduce the pressure below that without destroying the illuminating power of the gas. The ordinary day pressure of gas is from 8-10ths of an inch of water to 1 inch; the night pressure varies from 1 inch to 4 inches. The difference is owing to various causes. Mr. Williamson obstructs the flow of gas to the burner. He generally employed about 6-10ths of an inch; he could not go below 2-10ths without destroying its flame; but his patent has gone into disuse altogether. In Williamson's specification, there is nothing looked to but the saving of gas. There is no indication that the diminution of pressure tended to increase the illuminating power. If my gas-chamber was fitted on to his burner, where the gas was issuing at 2-10ths of an inch at the point of ignition, the illuminating power of my Argand burner would be reduced at least one-half. If the gas issued from Williamson's burner at the same pressure as there is in the Argand burner, there would be no flame at all—it would be like a torch. If there was a larger number of inlet-pipes than three, the diameter would have to be diminished, and they would be liable to choke. Three pipes distribute the gas better than two. I never saw porcelain used for bat's-wing and fishtail burners before 1869, but steatite has been used. Gas does not corrode steatite in the slightest, but it has an effect on metal burners. Iron burners are not corroded so much by the action of the gas as by the moisture which is generated in consequence of the burning of the gas. Steatite is, therefore, preferable to metal in fishtail and bat's-wing burners. In a bat's-wing burner, there is a cylinder on the top with a slit in it. The fishtail has the same kind of cylinder, with two holes drilled in it at the top, which incline towards each other. Those two burners produce different shaped flames, but both of them are flat, and require comparatively high pressure. Compared with the gas-chamber of an Argand burner, the chamber of a steatite bat's-wing burner would contain something like 4-10ths of a cubic inch of gas. The steatite chamber of the "London" burner, "G" size, would contain quite a cubic inch of gas, or about 1000 cubic tenths. The burner of porcelain shown me yesterday, marked "M. F.," had very small holes in it. It would not be possible to produce the same effect by substituting this for my steatite burner. The same effect could not be produced in my Argand burner if a metal chamber was substituted for a steatite chamber, because a metal chamber would expand the gas in consequence of the chamber becoming heated, and the gas would go out at a greater velocity, to such an extent as to prevent the oxygen of the atmosphere combining with the hydrocarbons of the gas in proper quantity for its illuminating power. The illuminating power of the gas would, consequently, be diminished. With regard to the castings, no man could produce the burners so geometrically exact as I could. Any one doing what I describe in my patent, and not knowing how to cast as I have described it, would not be able to compete with me in the market. My mode of casting tends to produce uniformity in the size of the burners. This is a most important thing in the manufacture of standard burners, where even a deviation of 1-100ths of an inch would not be allowed. That uniformity in the manufacture results in the uniformity of the results produced by the burners.

Mr. *Robert Hogarth Patterson*, examined by Mr. CAVE.

I reside at 21, John Street, Adelphi, and was one of the referees under the City of London Gas Act, from 1868 to 1872. It was my duty, as one of those referees, to obtain a good standard burner. We found the test burner at the time we entered on our duties was the Sugg-Letheby. We took every means in our power to find the best burners in use, and made a large collection of them with the view of obtaining the best. We found Sugg's "London" Argand burner much better than any of the rest. It was superior to the others by two candles. The Sugg-Letheby and one of Leoni's Argand burners were next to this in quality. If they gave 14 candles, Sugg's "London" gave 16, which was a great advance. The distinguishing features of Sugg's Argand burner is that it passes the gas without pressure, and that it keeps comparatively cool. Those two features had never been attended to in Argands. There were never any Argands at which the gas issued without any pressure, as was the case in the "London" Argand. The "London" Argand was the one used for testing common gas. Attention had been paid to the heating of the burner, and the opinion then was, the hotter the gas was made in the burner the better, so that the keeping of the gas cool was a decided novelty. I agree with Mr. Sugg that heat would have the effect of increasing the volume of the gas, and, therefore, of increasing the velocity. I am not a civil engineer, nor am I a professional chemist, although I know something about chemistry.

Cross-examined by Mr. HARRISON: I was bred as a civil engineer, but have not followed the profession. The two features of diminishing the pressure and keeping the gas cool had never been attended to together in the construction of other burners; nor had the keeping down of the temperature ever been attended to. I have seen pieces of wool put in the stem of flat-flame burners, for the purpose entirely, I believe, of economizing the gas. I became a gas referee in 1868.

By His LORDSHIP: I was not employed in gas-works previous to that.

Cross-examination continued: I had not made investigations as to what were the best gas-burners previous to 1868. I had no more information as to the subject of gas than any ordinary man. I inspected a boxfull of burners in 1868. I did not study any of the patents at the time. I never saw Williamson's burner before yesterday, and therefore have no practical knowledge of its operation. My attention has never been called to Durich's or to Johnson's. A flat-flame burner was used for testing cannel gas. If the holes were sufficiently large to admit of expansion, my impression is that it would spoil the flame, especially if the size of the holes were carried too far. If the holes of Mr. Sugg's burner were enlarged, my opinion is that it would be damaged. I know Mr. Sugg's burner, but have not studied the specification. The requirements of a standard burner are the best possible that can be obtained for common use, which will give the largest amount of light from the same quantity and quality of gas, and that will secure a test on the gas companies.

Re-examined by Mr. CAVE: We had to adopt a flat-flame burner for cannel, and an Argand burner for common gas. We had a large number of burners sent in for approval, but amongst these there were neither Williamson's, Durich's, nor Johnson's. I think Brönner's patent is used for increasing the illuminating power of the gas by diminishing the pressure. I have known that burner since 1869, but not before. It is a flat-flame burner.

Mr. *John Sampson Pearce*, examined by Mr. WEBSTER.

I am a civil engineer, carrying on business at 21, John Street, Adelphi. I have been in business for 20 years. I was also one of the referees under the City of London Gas Act of 1868. We had a large number of gas-burners sent in, but I do not recollect whether we had Williamson's, Durich's, or Johnson's sent in. In my opinion, the best burner before the Act of 1868 was the Sugg-Letheby. We found that the "London" burner was an improvement upon the Sugg-Letheby.

Mr. ASTON said that he did not dispute the utility of the invention, and the question was not raised by the pleadings.

His LORDSHIP said in that case it would save the necessity of proving it.

Examination continued: I considered the distinguishing features of the "London" burner is the delivering of the gas cool at the point of ignition, with a minimum of velocity. I think that the coolness also adds to the illuminating power of the gas. I did not find any Argand burner in which those two results were obtained to the same extent or in the same way as in Sugg's "London" Argand burner. There is more metal in the Sugg-Letheby burner, which prevents its getting cooler. While the best of the other burners we tested gave 14 candles, Sugg's "London" Argand gave 16 from the same gas, and the same quantity. I have had my attention called to the specifications, particularly to those upon which Mr. Sugg was examined yesterday. They all appear to me to be flat-flame burners. In my opinion there is not one of them which directly points out the condition which is essential in Sugg's "London" Argand burner. A flat-flame burner will not burn at all if the pressure is reduced in the same way as it is in Mr. Sugg's "London" Argand. In my opinion the Williamson, Durich, and Johnson burners never came into use at all. Durich's burner does not disclose any of the conditions that must be followed in the construction of the "London" burner, and I say the same of Williamson's and Johnson's.

Cross-examined by Mr. ASTON: I find indications in some of the specifications that they decrease the amount of gas to be delivered in an economical point of view only.

Unless Williamson had told you distinctly that his invention would increase the illuminating power of gas, you would not have gathered from his specification that that would have been the result?—Yes.

Would you have known in 1859 or in 1868 that a comparatively low pressure gives you an increased illuminating power?—It was not a received opinion in those days.

It would be necessary to tell the public, in order that they might know it, at that time?—Yes; the public were very hard to convince.

Is there not in Sugg's specification the same absence of information that you find in Williamson's, as far as regards illuminating power?—I am not aware that he speaks of increasing the illuminating power.

He does not?—Well then, of course, it is not in the specification. It is essential in an Argand burner that the delivery of the gas into the gas-chamber should not be at a high rate of velocity. If you deliver it at a low velocity you will get better illumination then at a higher velocity. So far the reduction of the velocity at the inlet is a thing which must occur when the cone is screwed down. In Mr. Sugg's specifications I find all that is necessary to tell me of all the conditions that make up the Argand burner. The specification speaks of "holes" and "chambers," which leads me to understand he is speaking of an Argand burner, as there are no chambers in bat's-wing or fishtail burners.

His LORDSHIP said, in order to save time, he would intimate that he should ask the jury, as at present advised, whether or not this description in the specification would lead any practical experienced man (assuming that the invention was a really good improvement) reading it, to understand it to be that which would apply it to the Argand burner, or to make such a burner as Mr. Sugg's "London" burner was.

Cross-examination continued: It was not told in specific words that the lowness of temperature would increase the illuminating power; but it was inferred. Increase in illuminating power would, no doubt, be an economy in the consumption of gas.

Then if you were told that the result is economical, why should not you understand that economy in result would be attended with increased illuminating power?—Because economy in the one specification is the only thing pointed at. It is not pointed at in Sugg's specification.

Nor is the illuminating power?—That may be so; but the whole invention is to increase the illuminating power. Although this is not said, it is implied.

Cross-examination continued: I can hardly divest myself of the knowledge that I have acquired, as to the burner, other than that obtained from the specification. The cooling effect of the "London" Argand must be apparent over the Sugg-Letheby and other burners that had so much metal about them. If I had an alternative, I should prefer a non-conducting material. I cannot recollect before 1869 seeing a burner with an aperture and a chamber of non-conducting material. We had so many burners sent in at that time. As to the burner marked "M. F.," it is of such a construction that it might include the qualities of Sugg's "London" burner, but in a lesser degree. It is approaching to Sugg's burner. The delivery of the gas cool at the point of ignition at a minimum velocity, resulted from the construction of Mr. Sugg's "London" burner. Reading Mr. Sugg's specification, and without bringing my own knowledge to bear upon the subject, I should understand from it that the improvements in manufacturing and fixing together the principal parts constructed of metal would be done at one operation. I consider that if a man constructs a thing he manufactures it. I cannot tell the difference between the word "casting," mentioned in Mr. Sugg's later specification, and the specification of 1866, because I am not well enough acquainted with Mr. Sugg's works.

Witness was then being cross-examined as to the meaning of certain words contained in one specification as compared with another, when

A JURYMAN asked if such questions were necessary?

His LORDSHIP said that he did not think they were: he did not think that a good deal of the "special demurrer" which had been made to certain words in the specifications would result in much benefit, as he would by-and-by have occasion to explain to the jury what a specification was, and to ask them some questions on it.

After some little discussion,

Mr. ASTON agreed not to put the questions, but reserved the right, subject to his lordship's approval, of addressing the jury on that particular point afterwards.

Re-examined by Mr. WILLIAMS: Looking to Mr. Sugg's specification as a whole, and the drawings accompanying it, I should say, as a practical man, that it alluded exclusively to Argand burners. Mr. Sugg's invention of 1866 was a patent for an improved form of governor. The governor was a good distance from the burner, and the heating would not reach the governors. I am of opinion that the metal of the burners manufactured previous to 1869 would have been deteriorated by the heat. Previous to 1868 it was not a received opinion that illumination would be increased by diminution of the heat. The burner marked "M.F." is one of the old ones. It has small holes, and does not seem to be constructed on the principle of having free outlet for the gas at the point of ignition.

Mr. *George Wilson Stevenson*, examined by Mr. WEBSTER.

I am a civil engineer, and have had 30 years practice almost entirely with gas and water works. I have advised many gas-works, and since 1866 have been adviser to the Metropolitan Board of Works and the Corporation of London. For the last 20 years I have given my attention to gas-burners. Before 1860 the quantity of gas consumed was regulated by the smallness of the holes in the burners, taken in connexion with the tap. The gas delivered in old Argand burners was delivered at the high pressure of about an inch of a column of water, and the gas was impoverished by the heating of the burners. I am not aware that the velocity was increased. I am acquainted with all the various steps relating to Argand burners down to the "London" Argand. I consider Mr. Sugg's specification as referring to the burner. A workman of moderate skill, taking the specifications and drawings alone, could in my opinion construct the Argand gas-burner. The novelty of the "London" burner consists, in my opinion, of a combination of several things. The gas is regulated at the entrance to the chamber which is used in combination with the burner. Then the gas arrives at the gas-chamber by the tubes. There are three tubes, so as to give an equal distribution of gas in the chamber, which would not be the case with one or two; and the flame would be larger probably at the point of combustion above where the tube entered the chamber. Further, there is the gas-chamber itself, which is of sufficient magnitude, and made of a non-conducting material, and the apertures, through which the gas is absolutely burned, are of larger area in the aggregate than the conducting-tubes, so that the gas issues from the burner with an inappreciable pressure, and develops in the best way the illuminating power inherent in the gas. The whole design of the burner is novel; in fact, this burner took the gas world by surprise. The best known Argand burner in use in 1866 gave 12 candles illuminating power. The Sugg-Letheby burner of 1866 developed the illuminating power to the extent of 14 candles. This burner develops the illuminating power of the same gas at 16 candles. The decrease of velocity and coolness has never been pointed out in the same way as Mr. Sugg pointed out. I have examined about 20 specifications set up by the defendants. They all apply to bat's-wing burners, and in my judgment in no way anticipate Mr. Sugg's invention. They do not disclose the features essential to the "London" burner. The conditions that are suitable for a flat-flame are not suitable for an Argand, and *vice versâ*. I am prepared to go into the difference between the two classes of burners if necessary. The "London" burner was not only adopted for photometric or scientific purposes, but also for domestic use. Williamson's, Durich's, and Johnson's burners I am not aware ever came into practical use. Applying my present knowledge to them, they could not develop the same results as Mr. Sugg's "London" burner. Taking Mr. Sugg's specification as a whole, nobody with any knowledge of the subject would imagine that Mr. Sugg was speaking of a flat-flame burner.

Cross-examined by Mr. ASTON: Burners of multiple apertures are mostly of the Argand class, and burners with single apertures are mostly of the bat's-wing class. Speaking popularly, if burners with one aperture and burners with multiple apertures are referred to in a specification, I should think they referred to two classes; but scientifically I should not; because I have seen Argand burners made with single apertures and the circular slit. In the burner "M.F.," so often referred to, I could not make a calculation as to the area of the holes at the point of ignition, and the area of the apertures at the point of inlet. The gas through that burner could not be brought to the apertures of combustion, except under high pressure.

Assuming that the sum of the areas of the apertures of combustion will be greater than the sum of the inlet area, will it not follow, as a matter of course, that the velocity of the gas as it is allowed to issue through the orifice of combustion will be reduced?—Yes. The lowness of velocity will be in proportion to the difference of the areas. If the sum of the area of combustion was larger than the sum of the inlet area, there would be a low velocity.

If the holes of this burner, as they stand, were so small as not to be sufficient to lower the velocity, you could easily increase their effect as regards lowering the velocity by enlarging them?—Yes.

Then as you enlarge the holes at the point of combustion, you enlarge the velocity at the point of combustion?—Yes, but I am not sure. If you have the holes at the inlet sufficiently small, you might make the holes at the point of combustion considerably larger indeed. Therefore there might be an extent of enlargement which would neutralize the pressure altogether, and pressure and velocity are synonymous terms. If a porcelain burner were pricked several times, it would have its holes enlarged. Assuming that an Argand burner had its holes too small in the first instance, the natural wear and tear in the process of burning the gas might make the holes larger, especially if the pricker was used. I have seen any quantity of Argand burners with holes of various sizes before 1869; but at that time it was scarcely possible to drill holes of an equal size or at equal distances. In 1869 there were not the same appliances, and we did not get the same results in gas-burners as we have now.

Witness was then further cross-examined as to the relative merits of several burners, as compared with the "London" Argand burner.

Re-examined by Mr. WILLIAMS: There is no difficulty in apportioning areas of the inlet and outlet holes; and Mr. Sugg has been the first to apportion those areas to perfection. It is only by a series of careful experiments that the relations between the two areas can be determined. There is a marked distinction in principle between the Argand burner and the flat-flame burner.

Mr. *F. J. Evans*, examined by Mr. WILLIAMS.

I am a director of the Chartered Gas Company, and a Member of the Institution of Civil Engineers. Before I became a director of the company I was their engineer-in-chief. I am well acquainted with the flat-flame and the Argand burners, and corroborate the evidence given by previous witnesses as to their construction and the superiority of the Argand burner as a testing burner over all the others. I agree with Mr. Stevenson that the Argand burners took the gas world by surprise, so much so that the Metropolitan Board of Works objected to the companies using them, on the ground that the public obtained no benefit from the invention, as they thought that improvement was not in the gas itself but in the burners.

Cross-examined by Mr. ASTON: The improvement in the illuminating power of the gas is mainly due to the introduction of the steatite chamber, but partly to other alterations and improvements made by Mr. Sugg; and if any of these were taken away from it, especially the tubes, the "London" Argand burner would be no longer the "London" Argand burner.

Mr. *Thomas Wm. Keates*, examined by Mr. WILLIAMS.

I am consulting chemist to the Metropolitan Board of Works, and have examined the specification of Mr. Sugg's patent. I have been for many years acquainted with Argand burners. At the time they were introduced, the "London" Argand burner was a very great improvement upon previously existing burners. The improvement in the Argand burner consists in the constricted passage at the bottom, the narrow arms which lead from the regulator to the gas-chamber, the large holes, and the steatite chamber itself. Added to that also is the fact that the aggregate area of the holes of the conduit-pipes is less than the area of the holes at the point of combustion. These are all material to the combination of the burner, and the results produced by it. I have read the patent, and in it the combination is fairly and properly described. In my opinion a workman of ordinary skill could construct an Argand burner from the specifications and plans. I have read the specifications contained in the notice of objection, and in none of these is there, in my opinion, any anticipation of Mr. Sugg's invention.

His LORDSHIP said that the main question was whether or not the patent was a valid one. From what had taken place, it was not improbable that it might be said that if even the patent was a good one, anything the defendant had done was not an infringement of it. He thought that at the close of the case for the plaintiff, there should be an indication by the learned counsel as to what the points in the case and the legal objections were, so that he might know how the case was to be dealt with.

Witness was then cross-examined by Mr. HARRISON. He said that any simple mechanical contrivance of the same character that regulated the inlet of the gas into the chamber would be sufficient; but if any mechanical contrivance were made externally, it would not do so well. Whether the cone was put upwards or downwards would be immaterial, so long as there were means for constricting the gas at the entrance to the chamber. He looked upon the "London" burner as an instrument composed of many parts adjusted to one another, and if one part of it was taken away, of course it would not be the same burner. He had not tried experiments upon the steatite chambers.

Mr. *Thomas N. Kirkham*, examined by Mr. WEBSTER.

I was engineer-in-chief of the late Imperial Gas Company, and am a Member of the Institution of Civil Engineers. I generally corroborate the evidence of the other witnesses as to the distinction between the flat-flame and the Argand burners. I have seen Mr. Silber's burners, and examined them; in fact, I have used many of them for experiments, and for the purpose of seeing whether they infringed upon Mr. Sugg's patent. I found almost the same combination in the Silber burner as in the Sugg "London" burner. There is a contrivance for regulating the inlet of gas into the chamber. It is an upright cone, instead of an inverted cone, as in Mr. Sugg's. There is also a chamber with a plate on the top of it, and at the side of that chamber orifices through which the gas passes into the chamber of the burner. [Witness then fully described the construction of the burner by means of a drawing.] From experiments I have come to the conclusion that the Silber burner gives the same illuminating power as Mr. Sugg's burner, as it is almost identical in structure. The Trinity burner is Sugg's "London" burner, with certain additions to it. There is a difference between the two cones in the two burners. The top of the cone in the "London" burner is nearly level with the top of a steatite chamber, and is not at all contracted, leaving an orifice of an eighth of an inch between it and the chamber of the burner. The Trinity House cone is contracted; it has a round shoulder to it, and is brought up over the top of the chamber of the burner not quite an eighth of an inch. Taking those two additions away from the Trinity burner, there would remain Sugg's "London" burner exactly. The only difference is to bring the flame down more to the focus of the reflector. There is no substantial difference in the form of the tubes. In the Silber burner there is a tube that somewhat represents the central tube. The air-cone is gathered over in the same way as Mr. Sugg's Trinity burner is. I saw no difference, either in principle or operation, between Mr. Sugg's Trinity burner and the Silber burner.

Cross-examined by Mr. ASTON: I do not mean to say that each particular part of the three novelties of Mr. Sugg's Argand burner is new. The restriction of the flow of gas into the chamber of the burner is decidedly new. This is caused, first, by the regulators, by means of the washers; and the tubes are very much smaller for restricting the supply to the chamber than in other burners. The means of restriction in the governor patented by Mr. Sugg in 1866 are the same in substance as in the patent of 1869, if it is taken as a tap. I have heard the evidence given by Mr. Stevenson and Mr. Evans, but I do

not agree with Mr. Evans, that the increase of illuminating power is almost wholly due to the cooling of the gas. There are no tubes to be found in the Silber burner surrounded by the atmosphere. I have bought several burners from Mr. Silber, but I do not recollect that there are any washers in connexion with the nose-piece. I believe that the screws of the nose-piece that go into the burner are all of the same size, and that it would be possible to have them interchanged; but I cannot prove that any washers have been introduced in connexion with the nose-piece. There is no novelty in an air-cone to a burner, and I do not consider the air-cone essential to the characteristics of the original Argand burner.

Mr. ASTON, in answer to the judge, said that as his lordship would direct the jury by-and-by as to what was the meaning of the claim, as indicated in the words, "the constructing, manufacturing, and means employed in making gas-burners," he (Mr. Aston) should contend that the claim was either a claim for a combination in its entirety of the means of manufacturing that combination, or else it was a claim for some subsidiary novelty in the entire combination. If it was a subsidiary novelty in the entire combination, as far as the parts went to form the entire burner, then it would be for the plaintiff to make out that all the parts that go to make that combination were contained in the Silber burner. If, on the other hand, the plaintiff said that it was nothing less than the entire combination, then he should ask his lordship to rule that the specification was not sufficient, upon the authority of *Foxwell v. Bostock* (4 De Jex and Smith), and to hold in point of law that, if there was anything other than the entire combination claimed, the specification was not completed, because it would not be found in that case what was the subsidiary part or what was the subsidiary combination. Besides that, he held that if the claim included any process of manufacture, it must include the process of manufacturing the parts by well-known castings, and that the only point which was to be relied upon, was the casting in metal moulds that were not described—the casting in one piece that which had been previously cast in several pieces. He should ask his lordship to hold that that was not good authority for a patent.

Justice BLACKBURN: Before I say whether it is good authority for a patent, I should like to see whether or not it is claimed. The patentee says, in effect, "I have discovered this, which I say is a new thing. I have discovered in the Argand burner that which is contrary to what was previously supposed, that the point through which the gas issues should be as small as possible, and that the gas should, as nearly as possible, be kept as cool as the surrounding air. That was, no doubt, a general principle; but that general principle I have brought into general use, and the means I have found for doing it I now proceed to describe." but I do not see that he claims all the means.

Mr. ASTON: Then what is the meaning of the words, "the means employed?"

Justice BLACKBURN said that when all the principles that had been mentioned, with anything that was equivalent in substance to the means, there was an infringement; but the plaintiff could use as many mouldings for castings as he pleased.

Mr. ASTON: Then your lordship will not give any effect to the words, "for the means of casting," and so on?

Justice BLACKBURN: I will give that effect as at present advised upon it; and if there is any point of law it can be reserved. The principal question for the jury will be, Is this a new or meritorious invention? and, if so, is it described in a way that would enable a man of moderate skill to make a burner? and, lastly, is Mr. Silber doing the same thing as is put forth in the improvement? Of course, I must wait till I hear Mr. Silber's evidence.

Mr. ASTON: I shall ask your lordship to put in the alternative, whether the application of the principle of lowering the cooling in the burner aperture is old or not.

Justice BLACKBURN: I think you have indicated enough to enable us to see the real points which we will have to consider when we come to them.

[We shall continue the report in our next number; meanwhile, it may be stated that the trial lasted until Saturday, the 20th inst., when the jury returned a verdict for the plaintiff.—ED. J.G.L.]

Miscellaneous News.

METROPOLIS GAS SUPPLY.

METROPOLITAN BOARD OF WORKS.

At the Weekly Meeting of the Board on Friday last—Sir JAMES HOGG, M.P., in the chair—

The Parliamentary Committee presented the following report:—

Your committee have to report that they have had before them certain proposals made by the London, Phœnix, and Surrey Consumers Gas Companies to the Board of Trade, as to the terms upon which they would be willing to be placed under the same regulations as those already settled for The Gaslight and Coke Company, and incorporated in the company's bill now before Parliament, and that they attended before the Board of Trade, and had a conference with the companies. It may be well to remind the Board that these regulations are mainly as follows:—That gas of 16-candle power shall be supplied; that the standard price of the gas shall be 3s. 9d. per 1000 cubic feet; that the standard rate of dividend for the ordinary stock shall be 10 per cent., the rate of dividend to rise or fall inversely with the price of the gas in the ratio of one-quarter per cent. of dividend for each 1d. of increase or reduction of price; that the standard of purity of the gas shall be prescribed by gas referees appointed by the Board of Trade; that the gas shall be tested daily by the Board's officers, the company being liable to certain penalties for any defect of illuminating power or purity; and that all capital shall be offered to the public by auction or tender, and allotted to the highest bidders. These are the main points agreed upon by The Gaslight and Coke Company, and which the companies on the south side of the river are willing to adopt on some concessions being made to them. The concessions which they require are as follow:—

1. That they shall at once have power to increase their capital *pro rata* or thereabouts with the increase granted to The Gaslight and Coke Company, except that in the case of the Surrey Consumers Company, whose capital is small, a larger increase in proportion shall be granted. It appears to your committee that there is no objection to the companies having an increase of capital *pro rata* or thereabouts with the increase conceded to The Gaslight and Coke Company, having regard to the fact that the new capital will not be, as heretofore, allotted to the shareholders, but will be submitted to public tender, and the highest offers accepted. They, however, do not concur in making any exception in favour of the Surrey Consumers Company.

2. The companies further propose that power should now be given to them to acquire such additional land as they may show to the Board of Trade to be necessary for the purposes of their works, so as to avoid the necessity of applying to Parliament on each occasion. By this they do not mean compulsory power, but only power to take land by agreement. It appears to your committee that there is no objection to this, provided that, when the companies apply to the Board of Trade for a certificate to authorize the acquisition of any land, this Board shall have due notice of it, and be empowered to appear before the Board of Trade to state any objection which there may be to the proposal, and to call evidence particularly as regards any injury or nuisance to the neighbourhood.

3. The companies further wish to have the same powers of amalgamation as those held by The Gaslight and Coke Company, under its Act of 1871. This company has power to submit to the Board of Trade at any time a scheme of amalgamation with any other metropolitan gas company, and the Board of Trade, after considering the proposal, and hearing the representations of this Board, may consent to the scheme, and get it confirmed by an Order in Council. It appears to your committee that the London, Phœnix, and Surrey Consumers Companies may fairly have powers of amalgamation among themselves with the consent of the Board of Trade, this Board to be heard upon, and have power to object to, any amalgamation, but inasmuch as the Board, by a resolution on the 5th inst., decided to oppose the clause in the bill of the South Metropolitan Company now before Parliament to give that company power to amalgamate, it appears to your committee that any power of amalgamation must not include the South Metropolitan Company.

4. The companies further propose that they should not be subject to the jurisdiction of the gas referees appointed by the Board of Trade, who, under a recent Act of Parliament, are required to decide what amount of sulphur and other impurity shall be allowed in the gas, and that if they are subjected to them they should have some power of appeal. Your committee are of opinion that there is no ground for placing the companies on the south side of the river under different conditions in this respect from those to which the companies on the north side are already subjected, and, indeed, it does not appear to your committee that there is any objection to the control exercised by the gas referees over the purity of the gas.

5. It is proposed that the bill to give effect to the proposed arrangement shall come into operation on Jan. 1, 1877, with some exception as to the power of forming a reserved fund. It appears to your committee that this date is a proper one, and with regard to the proposed exception, that will be referred to subsequently.

6. In addition to the above, the Phœnix Gas Company ask for power to issue its existing debenture stock at a rate of interest of not more than 5 per cent., instead of 4 per cent.—the amount to which it is at present restricted. Your committee see no objection to this alteration.

7. The London and Surrey Consumers Gas Companies further ask for power to make up their respective reserved funds upon the existing terms, until such funds amount to the sums named in their respective Acts of Parliament, or until Jan. 1, 1879. The company's representatives have since expressed their willingness to modify this proposal, as follows:—That during two years from the passing of the proposed bill, so long as the price charged by the companies shall not exceed 3s. 9d. per 1000 cubic feet, and so long as their dividend shall not exceed 10 per cent., they shall be entitled to carry to their respective reserved funds an amount not exceeding, in the case of the London Company, £50,000, which would be the amount required to bring the reserved fund up to the sum named in its Act of Parliament, and in the case of the Surrey Consumers Company, such sum as might be necessary to make up its authorized reserved fund. Your committee cannot recommend the Board to agree to this proposal, the effect of which would be to postpone the operation of the sliding scale of price and dividend in the case of these two companies for two years.

Your committee may mention that the companies representatives desire that in the event of an agreement being come to between them and the Board, the bill to give effect to the arrangement may be introduced by the Board of Trade. It appears to your committee that as the Board has a bill before the House of Commons which has been read a second time, the best course would be for the Board's bill to be amended in the manner necessary to give effect to the arrangement. It is understood that the South Metropolitan Gas Company shall not be included in the arrangement, inasmuch as it has a bill before Parliament, which is now under consideration by a select committee of the House of Commons.

Mr. ROCHE, in moving the adoption of the report, remarked that at the last meeting of the Board it was desired by several of the members that a communication addressed by the Board of Trade to the chairman, respecting the propositions dealt with in this report, should be read and publicly discussed. The Board, however, declined to accede to that proposition, and in his opinion very fortunately so, for when a conference subsequently took place between the Board of Trade, this Board, and the gas companies, it was said that that communication was entirely of a private character, and was written without prejudice to either party, so long as the suggestions contained therein were simply the subject of negotiations. Therefore, the Board at the present time were entirely unpledged in the matter, and were at perfect liberty to adopt the report before them or not, as they thought fit. He should mention first that they had been successful in getting the Regulations Bill read a second time in the House of Commons, although there were several gentlemen from the Surrey side of the Thames who were favourable to its withdrawal. Since then the companies in the south of London had come forward with proposals to adopt the provisions of the Board's bill, so far as they were included in the Chartered Company's bill, and asking certain concessions at the hands of the Board. If the report now submitted was adopted, he thought he could say that they might hope, at no very distant date, for a definite settlement of the gas question in the Metropolis. The southern companies proposed, in the first instance, to adopt the legislation of the Chartered Company's bill. They accepted the sliding scale, they adopted the initial price of 3s. 9d., and they adopted what were known as the auction clauses, which were the three main features of the Chartered Bill, which it was believed would operate for the protection of the consumers, making the interests of the companies almost identical with those of their customers. The concessions the companies asked were these. The first was an increase of capital *pro ratâ* with the increase granted in the case of the Chartered Company. The committee recommended that this concession should be granted. An exception was asked in respect of the Surrey Consumers Company, but the committee recommended that this exception should not be allowed, but that perfect uniformity should be maintained. The companies then asked for powers to obtain more land without going to Parliament, and the committee recommended the Board to yield, on condition that the companies should only be able to purchase land by agreement, not compulsorily; that the sanction of the Board of Trade should first be obtained, and that this Board might be heard before the Board of Trade in opposition to any such proposal. To these conditions, he believed, he he was right in saying the companies had agreed, and the committee thought them quite sufficient for the due protection of the interests of the public, the Board being, of course, empowered to consult with the local authorities. Then, with regard to the question of amalgamation, the companies asked for the same powers as those possessed by the Chartered Company, and the committee recommended the Board to concede this point so far as to allow them to amalgamate *inter se*, but not with the South Metropolitan Company. He had no doubt that this portion of the report would be opposed, but whatever reasons there might have been in the past against amalgamations, when all the companies were under one general law as to price, quality, and illuminating power, the same objections did not exist, and it was made the interests of every one of the companies to work as cheaply as possible, and no public interests could be served by preventing them from amalgamating. The next proposal was to do away with the interference of the gas referees with regard to the sulphur question, but the committee advised that the same course should be pursued as was adopted in the case of the Chartered Company's bill, where the referees were retained. The Phœnix Company then asked that they should be allowed to raise their debenture stock at a rate not exceeding 5 per cent., and to this the committee saw no real objection. With regard to the reserve-funds, it was asked by the London and Surrey Consumers Companies, in effect, that until January, 1879, the sliding scale should remain in abeyance, in order that the companies might be allowed during that time to make up their reserve-funds out of profits to the full amounts named in their respective Acts. To that proposal the committee recommended the Board not to agree, as it would be entirely inconsistent with the conditions imposed in the case of the Chartered Company. The London Company, at the present time, had a reserve-fund of £35,000, and the committee thought that quite sufficient for any purposes for which it might be required. It had been further suggested that the Board of Trade should introduce an entirely new bill, embodying the points agreed upon by this Board and the companies; but to this the committee thought the Board should not agree, but that the Regulations Bill should stand, such alterations being made therein as might be agreed upon. No doubt there would be some opposition to this report from those representing the southern districts; but the recommendations of the committee gave effect to the main principles so long fought for by the Board, and it simply applied the provisions adopted by the companies supplying the north of London to the southern companies, with some slight concessions, and he thought the Board would act wisely in adopting the report.

The adoption of the report having been seconded by Mr. LLOYD,

Mr. FOWLER said he regretted that the motion had been seconded by a gentleman representing a district on the south side of the Thames. He thought the majority of the southern members did not think justice had been done to the consumers by the proposed arrangement between the companies and the Board. They objected especially to this piecemeal legislation. They were quite

satisfied and contented that the principles of a Regulations Bill should apply to every part of the Metropolis, and when that principle was endorsed by the Board, they were contented to abide by it, until they saw the Regulations Bill virtually superseded on the north side of the Thames, by special agreement between the Board of Trade and the companies, and the Metropolitan Board. It seemed now that, on the south side of the Thames, the same sort of policy was to be pursued. Instead of the whole matter being settled upon the principles laid down by this Board in framing the Regulations Bill, the outcome of the whole matter was this: As far as the south side was concerned, that the consumers would have to pay a larger amount for gas than they paid before any legislation at all was attempted on the subject The Phœnix and the London companies were supplying gas to a large district at a less price than it was proposed to fix in this Bill.

Mr. E. DRESSER ROGERS: They are supplying it at 3s. 6d.

Mr. FOWLER said that they were supplying gas at a less price than the consumers would have to pay under the arrangement proposed to-day as a settlement of the question between the gas companies and the Board. He objected very much to the way in which the local authorities were being treated in the matter. There seemed to be a disposition on the part of the Board—and he did not think it was to the interests of the Board to pursue such a course—to shut out those parties more immediately interested from having anything to do with the question. If amalgamation was to be permitted, the local authorities, as well as the Board, should have the opportunity of saying something about it. But the local authorities were excluded from having any voice in the matter. That was a very unfair thing. It was no use for the Board to say they were acting on the principle of uniformity, for they had decided already that they would not allow an important company to amalgamate, unless they went to Parliament. Now if this was a good principle in one case, it should be applied to all. He should be contented if the Board gave the companies permission to amalgamate *inter se*, provided the terms of the amalgamation were submitted to Parliament, so that the Board and the local authorities might have a *locus standi*, and an opportunity of urging their views. It was, otherwise, useless to talk about uniformity. In the first instance if the bill had passed as originally proposed, he did not think the consumers on the south side or the north would have made individual objections respecting their particular districts, because they were to be all under one rule. But now the Board had abandoned that position, he thought it was most unfair that separate companies were to be heard before the Board of Trade, and to have the opportunity of getting distinct exceptions made from the general rules in their favour. Therefore he objected most strongly to the proceedings of the Board in agreeing to a compromise, as it was called, between the companies and the Board of Trade. It ought to be settled as a question of principle. He knew the south were in the minority, and he was sorry to see the southern members did not go together as they should. Still, he must move an amendment to the recommendation of the Parliamentary Committee in these terms:—"That this Board having, by resolution, expressed their opinion that no company should be amalgamated without the consent of the Board, the present proposal for amalgamation should not be conceded except with the assent of Parliament, so that the local authorities may have the opportunity of being heard." He was alluding to a resolution of the Board of the 5th of February, 1875, and he said that the Board having affirmed the principle that no amalgamation should take place without their consent, it was only fair and reasonable to adopt the amendment he had proposed, instead of the report of the Parliamentary Committee, which did away with the Regulations Bill; and it was only fair that the local authorities should have the power of being heard before Parliament whenever any amalgamation took place. It had been admitted not only by this Board, but by the Board of Trade, in their letter of the 23rd of November, 1875, that the amalgamations which had taken place were entirely in the interests of the companies and not of the consumers. He thought, therefore, that no legislation affecting the interests of the consumers should take place without their having the opportunity of urging their views before a proper tribunal.

The CHAIRMAN said it was true that early last year the Board passed a resolution in opposition to amalgamation unless under certain conditions. The Board, however, had since changed that opinion when it agreed to the amalgamation of the Ratcliff with the Commercial Company, and more recently in the case of the amalgamations with the Chartered Company.

Mr. E. DRESSER ROGERS, in seconding the amendment, remarked that although, as stated by the chairman, the Board had varied their resolution referred to by Mr. Fowler, they had only a week or two since again changed their mind when they resolved to oppose the amalgamation clauses of the South Metropolitan Company's bill. With reference to the proposal that the companies should have the power to take land by agreement upon application to the Board of Trade, and with the consent of this Board, he thought his friend Mr. Fowler had spoken by no means too strongly on behalf of the local authorities. The local authorities were far more likely to be aware of the objections that might be urged against the appropriation of land in various parts of the metropolis for gas-making purposes than this Board, and he did think that in this matter the vestries and district boards might have been treated with greater consideration. If these concessions were to be made, he certainly thought the local authorities should be afforded every opportunity of stating their views. The question of the proposed amalgamation was a very important one. Through some mistake the Chartered Company in their bill had retained the power to amalgamate.

Mr. RUNTZ said it was no mistake.

Mr. E. DRESSER ROGERS said he would use the word "misunderstanding;" but, as a matter of fact, it was never contemplated by two-thirds of the members of this Board, when they sealed a copy of the bill of the Chartered Company, that the power of the company to amalgamate remained intact. At the present time The Gaslight and Coke Company, possessing this power, might amalgamate with any of the companies on the Surrey side of the river, but being masters of the position, they could make their own terms, the southern companies having no power to amalgamate. The southern companies, however, now sought to obtain this power, and if successful they would also be in a position to make their own terms in any amalgamation that might be proposed. That, he affirmed, was the real point of this suggestion. No matter what this Board might do, if any amalgamation took place in South London the South Metropolitan would be one of the companies amalgamated. That company at the present time were charging 3s. per 1000 feet, declaring a 10 per cent. dividend, and putting by large sums to a reserve-fund, but if they got the power to charge 3s. 9d., they would be enabled to pay 11½ per cent. dividend, and in the event of any amalgamation they would not be contented with less than 11½ per cent. guaranteed dividends in perpetuity. Notwithstanding the hints of the chairman of Parliamentary Committee, therefore, it would be seen that the members of this Board for the south of London had some cause for the line of action they had taken. He had no hesitation in saying that if the proposals the Board were now asked to agree to were carried out, it would cost the consumers of gas in South London £30,000 a year; and in the district of Lewisham, where the price was now 3s. 6d., it would cost the consumers £10,000 a year. It had been said, however, that the gas companies would not take advantage of the passing of the Regulations Bill to increase the price of gas, and reference had been made to the manner in which the price had recently been reduced—in many instances without any special motive, and only in the interests of the consumers; but

> When the devil was sick, the devil a saint would be;
> When the devil was well, the devil a saint was he.

He (Mr. Rogers) was not a gas director, nor a gas shareholder, and therefore was not aware of the secrets of the companies; but he generally found, in his experience, that the companies invariably looked after themselves, and whenever they had the chance to raise their price they generally did so. Referring again to the question of amalgamation, would any one venture to say for a moment that the amalgamation of the Imperial and Independent Companies with the Chartered Company would eventually result in the interests of the consumers? Where was the competition between the different companies, and especially between the engineers and managers? It was a matter simply for the personal aggrandisement of the directors and shareholders, utterly regardless of the interests of the consumers. He was glad to find that the committee had not given way on the sulphur question, and also with regard to the reserve-funds; and he quite agreed with them that the Board should not so far stultify itself by allowing the Board of Trade to promote an entirely new bill on the subject. That very day they had three counsel fighting for the consumers of the South Metropolitan Company's district, and it was, therefore, perhaps, right that that measure should be excluded from the report before the Board; but it did appear a very anomalous state of things that that bill should have been referred to an entirely new committee, presided over by Mr. Walter, M.P., who had no special knowledge whatever of gas matters, after the consideration which had been given last year by Mr. Forster's committee for a period of 20 days to the whole question of the gas supply of the Metropolis.

Mr. TOLHURST much regretted the tone of the two previous speakers, and thought they had looked at the question from a local instead of from a metropolitan point of view. In his district they were paying 4s. for their gas, and therefore any legislation that took place on the principles of the Regulations Bill must result in an immediate advantage to his constituents. He should most certainly vote with the committee.

Mr. RUNTZ said in this matter, for two or three years past, the Board had been proceeding in one direction in endeavouring to secure uniformity of price, quality, and illuminating power over the whole Metropolis, but now, at the last moment, an attempt was made to get the Board to part from their original intention, because it was thought that one or two small districts on the Surrey side might be placed at a disadvantage under the arrangement proposed. He declared that the real object of those who opposed this report was to get an initial price of 3s. 6d. fixed for the south of London, and he referred to the following resolutions passed by the Board in February, 1875, on the motion of the late Mr. Newton, seconded by Mr. Fowler, viz:—"1. That the conditions to be applied to all the gas companies should, as far as possible, be uniform. 2. That the standard illuminating power of the gas supplied by them should be 16 candles. 3. That the standard price should be 3s. 9d. per 1000 cubic feet."

Mr. LLOYD spoke in favour of the report of the committee, and, in reply to Mr. Dresser Rogers, said he cared quite as much for the interests of his constituents as any member of that Board; but in this matter he was bound to take a broad view of the question, and to bear in mind that the whole Metropolis was interested and would be affected by their decision. Supposing the proposed arrangement was carried out, they would have secured what they had been fighting for for years past—viz., a motive for economy on the part of the companies, which would exist to a paramount extent.

Mr. RICHARDSON did not concur with Mr. Roche in regarding the second reading of the Regulations Bill as a cause for congratulation. What advantages were likely to accrue to the public from the success of that measure? He could not see any, and was afraid the result would be rather the other way. In his own district they were paying 3s. 6d., and, notwithstanding what had been stated by Mr. Tolhurst, he thought in no district in South London were the consumers charged more than 3s. 9d. He thought the real object of the companies in this matter was to obtain the power to amalgamate, to which he contended the Board should agree, the basis being the provisions of the bill of the Chartered Company, except that the initial price should be 3s. 6d., with the restrictions as to sulphur waived. His opinion was that if the Board allowed these companies to amalgamate, they would only be too glad to accept an initial price of 3s. 6d., if they could get rid of the clauses relating to the purification of gas, or some modification of their provisions. He would also allow the South Metropolitan Company to amalgamate, on the condition that they withdrew their bill now before Parliament.

Mr. POCOCK thought the Board would stultify itself by asking for the adoption of a 3s. 6d. initial price for South London, having assented to a 3s. 9d. price on the north side of the Thames.

Mr. R. JONES, who was imperfectly heard in the gallery, followed, and after some remarks from Mr. LESLIE and Mr. FREEMAN and a reply to Mr. Roche,

The amendment was put and negatived, and the report of the committee adopted.

Dr. Whitmore's report on the illuminating power, pressure, and quality of the coal gas consumed in the parish of Marylebone, and supplied by The Gaslight and Coke Company, during April:—

	Illuminating Power in Sperm Candles.			Mean Pressure in Tenths of an Inch.		Mean Quanty. of Sulphur in 100 Cu. Ft.	Mean Quanty. of Ammon.in 100 Cu. Ft.	Sulphuretted Hydrogen.
	*Mean of Obser.	Highest.	Lowest.	Highest.	Lowest.	Grains.	Grains.	
Gas supplied from the Fulham works . .	16·31	17·01	15·81	23·60	8·70	19·13	0·40	No trace
Gas supplied from the Beckton and Bow works	16·36	16·96	15·91	30·84	14·74	13·38	0·60	No trace
Cannel gas supplied from the Pimlico works	20·67	22·81	19·30	18·98	11·64	16·45	0·50	No trace

Mean of daily readings of barometer. . . . 29·61
" " " thermometer . . . 61·45

* Each observation consists of ten readings of the photometer, at intervals of one minute.

During the month, the common gas supplied to the parish from the Fulham works gave a mean illuminating power equal to 16½ candles; it ranged between 15·81 and 17 candles; twice only it fell below 16 candles. The mean quantity of sulphur found in 100 cubic feet of this gas was 19 grains, and of ammonia 4-10ths of a grain. The common gas supplied from Beckton and Bow gave a mean light also of 16½ candles; it ranged between 15·91 and 16·96 candles; once only it fell 1-10th of a candle below the standard. The mean amount of sulphur found in it was 13·38 grains, and of ammonia 6-10ths of a grain. The cannel gas gave a mean light equal to 20½ candles; it ranged between 19·30 and 22·81 candles; once only was it below the standard of 20 candles. The mean quantity of sulphur found was 16·45 grains, and of ammonia half a grain. The pressure of all the gases was good, and on no occasion was sulphuretted hydrogen detected in either of them by the ordinary tests.

METROPOLIS WATER SUPPLY.

The Registrar-General publishes the following returns of the average daily quantity of water supplied by the London Water Companies during the month of April, 1876. According to these, 114,315,996 gallons, or 519,390 cubic mètres of water (equal to about as many *tuns* by measure, *tons* by weight) were supplied daily; or 217·6 gallons (98·9 decalitres) rather less than a *ton* by weight, to each house, and 30·6 gallons (13·9 decalitres) to each person. According to returns of the London Water Companies made to the select committee on East London Water Bills (session 1867), it is estimated that, during

the year 1866, about 82 per cent. of the total supply of water for all purposes was for domestic use; applying this proportion to the total quantity supplied daily in the month of April, 1876, it may be estimated that about 93,739,117 gallons were used for domestic purposes, or about 25·1 gallons per day for each inhabitant, against 25·2 in the corresponding month of last year.

Companies.	Number of Houses, &c., supplied in April, 1875.	Number of Houses, &c., supplied in April, 1876.	Aver. Daily Supply of Water in Gallons* during April, 1875.	Aver. Daily Supply of Water in Gallons* during April, 1876.
Total supply	517,208	525,369	113,045,907	114,315,996
From Thames	243,090	247,328	57,057,411	59,272,347
„ Lea and other Sources	274,118	278,041	55,988,496	55,043,649
THAMES.				
Chelsea	28,555	28,675	7,278,900	7,310,500
West Middlesex	46,738	47,800	9,505,987	9,662,837
Southwark and Vauxhall	79,984	80,413	18,106,000	19,465,000
Grand Junction	35,709	36,616	10,460,424	10,541,910
Lambeth	52,104	53,824	11,706,100	12,292,100
LEA AND OTHER SOURCES.				
New River	123,137	124,135	26,519,000	24,963,000
East London	107,294	109,375	22,770,500	23,452,000
Kent	43,687	44,531	6,658,936	6,628,649

* Including that for manufactures and for various purposes other than for domestic consumption.

Note.—The return for April, 1876, as compared with that for the corresponding month of 1875, shows an increase of 8161 houses, and of 1,270,089 gallons of water supplied daily.

Dr. Whitmore's report on the composition of Thames companies and other waters supplied in Marylebone during April:—

	Total Solid Matter in degrees or grains per Imperial gallon.		* Loss by incineration of Solid Matter in previous column.		Hardness before boiling, in degrees.	Hardness after boiling 15 minutes, in degrees.
	April, 1875.	April, 1876.	April, 1875.	April, 1876.		
Distilled Water	0°	0°	0°	0°	0°	0°
West Middlesex	20·00	21·92	0·92	0·96	15·60	3·50
Grand Junction	20·24	21·60	0·96	1·04	15·40	3·30

* The loss by incineration represents the amount of organic and other volatile matters contained in the Imperial gallon (70,000 grains) of water.

	Chlorine in Grains per Gallon.	Parts per Million. Free Ammonia.	Albuminoid Ammonia.
West Middlesex	1·05	0·010	0·068
Grand Junction	1·15	0·008	0·080

The Thames water supplied to the parish by both companies was generally bright, clear, and nearly colourless. Its improved purity was shown by the small quantity of albuminoid ammonia found in it.

Dr. Frankland, F.R.S., reports, as the result of his analysis of the waters supplied to the Metropolis during April, that, taking unity to represent the amount of organic impurity in a given volume of the Kent Company's water, the proportional amount found in an equal volume of water supplied by each of the other metropolitan companies was—New River 1·7, East London 2·1 West Middlesex 3·1, Grand Junction 3·4, Southwark 3·5, Chelsea 4·2, and Lambeth 4·4. The effect of the excessive pollution of the Thames water during March had abated, and that of the Lea water had disappeared, by the middle of April, when the last samples were taken for analysis. The waters delivered by the Chelsea and Southwark Companies were "slightly turbid and contained moving organisms;" the Southwark water also contained "confervoid growths." All the other companies supplied water that had been efficiently filtered. The Kent Company's water derived from deep chalk wells, was "clear, brilliant, and wholesome."

CHELSEA VESTRY.—At the meeting of the vestry on the 2nd inst., Dr. Barclay made the following report:—"Since my last report of the water supplied to this parish by the Chelsea Water Company, several analyses have been made, at irregular intervals, of the water obtained from the company's main. Notwithstanding the continuance of wet weather, and occasionally heavy rainfall, only very slight discoloration has been observed, and a very small amount of sediment after standing 24 hours. The total solid constituents have somewhat diminished during the last two or three months, and throughout there has been found only a very small amount of chlorine (one grain per gallon), usually no trace whatever of free ammonia, and almost an infinitely small amount of nitrogenous compounds (or albuminoid ammonia as it is called). In fact, the supply has been as good as river water can be expected to afford."

THE GASLIGHT AND COKE COMPANY.

An Extraordinary General Meeting of the Shareholders in this Company was held at the Offices, Horseferry Road, Westminster, on Friday, May 19—the Hon. R. HOWE BROWNE (the Governor) presiding—to consider a proposal by the Directors to convert or consolidate the shares in the capitals of the late Imperial Gaslight and Coke Company and Independent Gaslight and Coke Company respectively (now amalgamated with this company), into capital stock of the united company; and to consider a resolution to be submitted with reference to the remuneration of the secretary.

The SECRETARY (Mr. J. O. Phillips) having read the notice convening the meeting,

The GOVERNOR said—Gentlemen, this being a special meeting, called for the consideration of two important subjects, there is no necessity for us to have the minutes of any previous meetings read. As I anticipate that the time occupied in the discussion of the subjects for which this meeting is called, will occupy but little of your time, I will venture to ask you to allow me to refer to two or three other points, foreign, certainly, to the purposes for which we have assembled to day, but which, I think, will be received by you all with satisfaction, and may be useful as making the proprietors in general *au fait* with what has taken place lately. And first I have to offer you my congratulations and the congratulations of all my colleagues upon the important fact that we are assembled here to-day for the first time as the great united Gaslight and Coke Company. We have been so fortunate, since our last meeting in this room as the proprietors in the Chartered Gas Company, to have effected an amalgamation with the great Imperial Company, and also with the Independent Company, which, though a smaller company, has been as well managed as any company in London; and I think, as a united company, we shall verify in the future that old and much-used proverb which has found general acceptance in almost every country in the world—"Unity is strength." I know myself that that proverb has been translated into every language I have ever heard. We have it in French, in Italian, and in German. I believe it is a true proverb, and I am perfectly certain that in our case we shall prove its truth in our combination. For many a long day I trust we shall now be allowed to enjoy that repose to which we are so eminently entitled after our severe and protracted struggles of late years both in Parliament and elsewhere. The second point to which I will allude is also a matter for great congratulation. Some of our proprietors may not be aware that a most serious action against us has been pending for a long time in the courts of law. It is an action brought by a gentleman of the name of Patterson, who was one of the Government Gas Referees—i.e., an officer appointed by the Board of Trade. That gentleman took the opportunity of visiting our works, in his official capacity, for several years, and he seems to have thought that he might utilize his experience and the information he gained there, and turn it to his own advantage and profit. With that view he made special observations as to the system of purification of gas that was being carried on at some of our stations, particularly at our Beckton station, where we adopted the most efficient means known to the scientific world, and which means had been eminently successful. Availing himself of the information so acquired, he brought out a patent, while he still held office as a referee, so as to secure to himself the sole right to the use of the system of purification we had in use; and after he ceased to be a referee he brought an action against us for an infringement of his patent, and asked the court to grant an injunction prohibiting us from carrying on that system without his licence, and the payment to him of royalties. Well, gentlemen, that was a most costly and vexatious trial. It occupied Vice-Chancellor Bacon sixteen days in the hearing, at an enormous expense to the Chartered Company, as you may well suppose, and necessarily very large costs on the plaintiff's part. Who found him the money, I am not here to say; but certainly the costs of that action cannot have been less than several thousands of pounds. Well, gentlemen, the result of that trial was the most extraordinary judgment I think I ever read in all my experience. It was a judgment against the company on every point; in fact, we were bowed out of Court, and told we had not the slightest defence as against the plaintiff. This judgment, of course, received the serious attention of the directors of the Chartered Company, and we unanimously, and most fortunately, decided, upon the advice of our late engineer-in-chief and now director, my friend Mr. Evans, to appeal against the Vice-Chancellor's decision to a superior court. We did so, and the case has been argued for five days before the Lords Justices of Appeal, and I am happy to say that they have given a decision in favour of the company on every single point, reversing the decree of the Vice-Chancellor, and awarding us the whole of our costs. Now, many gentlemen present may not be aware of the magnitude and importance of this case as affecting us, not only financially, but in the way of carrying on our manufacture, and how enormously it concerned the united company. Mr. Patterson, in his action, claimed not only the back payment of royalties, but he would not even name a sum large enough for what he would demand in the future. Therefore, if the Vice-Chancellor's judgment had been confirmed, we should have been trammelled with heavy charges for years to come, if not in perpetuity, and could not purify our gas without infringing his patent. I do not know that I need say anything more on this subject, except that it will probably be brought before the House of Commons shortly, by way of an inquiry, to ascertain what steps, if any, the Board of Trade have taken, or are proposing to take, to prevent gentlemen occupying, as Mr. Patterson did, a public office, embracing the opportunity afforded them by their official connexion with companies to acquire information as to processes in use, and then trying to secure the benefit of them for themselves. Mr. Patterson supposed he had made a discovery, although it was proved in evidence that the same process that he patented had been previously in use at our Beckton station, and had for a long time before that been in use at Bow. Now, as I think the greatest possible publicity should be given to conduct so unworthy of any gentleman occupying so high a position as that of a gas referee, I have brought the matter forward to-day; and I trust the result of the trial will be a warning to all future referees, that they are not to turn the opportunities which their official position affords them, to their own advantage, and not that of the public. I will just ask Mr. Phillips to read a letter we have received from our solicitors, Messrs. Curtis and Bedford, respecting the case.

The SECRETARY read the following letter:—

Haberdashers Hall, Staining Lane, E.C., May 17, 1876.

THE COMPANY *a. t. s.* PATTERSON.

To the Directors of The Gaslight and Coke Company.

Gentlemen,—We have the honour and pleasure to report that the Lords Justices of Appeal gave judgment in this important case yesterday morning, and the same was unanimously in favour of the company, the appellants, upon *all* the issues in dispute. They consequently reversed the decision of the judge in the Court below, Vice-Chancellor Bacon, and dismissed the plaintiff's bill with costs, including the costs of appeal.

As the judgment enters fully into the facts and merits of the case, and printed copies thereof accompany this report, we need not trouble you by recapitulating them here, but we may call your attention to the fact that, not only do the Judges of Appeal find that all the five heads of the plaintiff's patent are bad, both for want of novelty and utility, but they also express a strong opinion that the mere fact of the plaintiff having been one of the gas referees, and having obtained all his information on gas purification in that character, would itself preclude him from taking out the patent.

We think the company have great reason to be congratulated upon the result of the appeal, for the more the matter was looked into and discussed, and the plaintiff's claims under his patent considered, the more it became evident that if the decision of the Vice-Chancellor were not reversed, it would be almost, if not quite, impossible for the company to purify by lime at all, without being liable to proceedings for the alleged infringement of the patent.

And although the plaintiff professed to be willing to treat on what he called favourable terms with the company, for the use of his so-called invention, yet, considering the magnitude of the united company, and the enormous make of gas on which a royalty would have to be paid, it is evident the amount thereof would have been very considerable.

We cannot conclude without again expressing our best thanks to Mr. Evans for his constant and most valuable help throughout the whole of these protracted and most complicated proceedings, and we have also derived much assistance from Messrs. Trewby and Harris, who have always been ready to offer all the assistance in their power. We have the honour to be, gentlemen, yours very obediently,

(Signed) CURTIS AND BEDFORD.

The GOVERNOR: The third point I wish to bring before you has relation to our bill in Parliament. I have merely to report that the bill passed through committee in the House of Commons yesterday, without a single amendment being carried against us. Our opponents, as usual, are a public body—the Metropolitan Board of Works—who are spending the money of the ratepayers, and not their own, and who have determined, as the costs do not come out of their own pockets, to oppose us again in the House of Lords. We have had notice from them to that effect; but I trust we shall be prepared to substantiate our case before that branch of the Legislature, and that we shall also be successful there. And now with regard to the special object of our meeting. It relates, first, to the consolidation into stock of the various shares of the united company—*i. e.*, all the stocks and shares of the Chartered, the Imperial, and the Independent Companies. No one, I think, in the present day can question the policy, and, indeed, the expediency, of such a course. We had authority from Parliament to do it so long ago as the year 1868, and the plan has been so generally approved in other companies—in railway companies especially—that I do not believe there can be any serious objection to it, whereas, on the contrary, it will be very advantageous in many ways. It will give the shareholders very great facilities for purchasing and selling, and it will create a very important saving of labour in the office of the company. I will explain to the meeting how it will affect each interest, new and old, and, to do so, I think I cannot do better than refer to a circular which will be sent to every shareholder, if the proposal is adopted by this meeting.

Shares of The Gaslight and Coke Company.

Each £10 ord. A share will be converted into £10 of ord. A stock of the united company.
„ £10 B share „ „ £10 of B stock „ „
„ £10 C „ „ „ £10 of C „ „ „
„ £25 D „ „ „ £25 of D „ „ „

Each unconverted £10 5 per cent. preference A share, 1st or 2nd issue, will be converted into £10 of A, 5 per cent. preference convertible stock of the united company.

Stock and Shares of the Imperial Gaslight and Coke Company.

Each £10 of stock will be converted into £10 of ordinary A stock of the united company.
„ £12 10s. share „ „ £12 10s. of H stock „ „

Shares of the Independent Gaslight and Coke Company.

Each £40 A share will be converted into £40 of E stock of the united company.
„ £10 B „ „ „ £10 of F „ „ „
„ £20 C „ „ „ £20 of G „ „ „
„ £10 D „ „ „ £10 of E „ „ „

The maximum dividends to which such stocks of the united company will be entitled will be at the following rates per annum, viz.:—

A, ordinary 10 per cent., or the maximum rate allowed by Parliament.		
A, 5 per cent. preference convertible. . .	5 per cent.	preferential.
B	4 „	
C	10 „	preferential.
D	10 „	„
E	10 „	„
F	5 „	„
G	7½ „	„
H	7 „	

Any amount of such stocks in the united company, not being less than £5, or a multiple thereof, may be transferred. Facilities will, on application at the company's office, be afforded by the directors to the holders of odd numbers of Imperial Company's £12 10s. shares, for the sale or purchase of H stock to the amount of £2 10s., in order that the holdings of such proprietors may be brought to a multiple of £5.

No doubt this latter arrangement will be very convenient to holders of shares of these particular classes. After the conversion into stock of these several classes of shares, there will remain for future conversion, when the whole of the amounts payable shall have been called up on the shares already created, but not paid up, £300,000 of those created in 1875; also £500,000 of the fourth issue of 5 per cent. preference, and another £500,000 upon the last or fifth issue. I hope you have been able to follow me in these figures, if not, I shall be happy to offer you any further explanations. Meanwhile I beg to propose—"That in pursuance of the scheme for the amalgamation of the Imperial Gaslight and Coke Company and the Independent Gaslight and Coke Company with The Gaslight and Coke Company, which was confirmed by order of Her Majesty in Council on the 24th of March last, the directors be authorized to convert or consolidate the shares in the capitals of the late Imperial and Independent Companies now amalgamated with this company, in respect whereof the whole money subscribed has been paid up, into capital stock of The Gaslight and Coke Company, to be divided amongst the shareholders according to their respective interests therein.

Mr. E. VAUGHAN RICHARDS: I beg to second the governor's motion.

Mr. SAYWELL objected to the shareholders being called upon, "on the spur of the moment," to decide so important a question, and moved, as an amendment, that the meeting be adjourned, and that a copy of the circular, detailing the arrangements referred to by the governor, be sent to each shareholder.

The amendment having been seconded by Mr. TILLEY,

Mr. S. A. BECK (the late governor) said he thought the proposal of the directors was one that required no time for consideration; the question being, in itself, so simple. It really was a proposal for an arrangement which would be a convenience alike to individual shareholders and to the company's staff.

Mr. YOOL said he was surprised that the amendment should come from a shareholder in the late Imperial Company, in which, for years, there had been both stocks and shares.

Mr. RICHARDS playfully remarked that, as Governor of the Imperial Company, Mr. Saywell and he were old friends, and he could safely say that he never knew a proposal to be brought before a meeting of shareholders to which Mr. Saywell did not move that the consideration be adjourned, for some purpose or other. Referring to the motion, he expressed a hope that it would be adopted, as the arrangement would greatly facilitate the business of the office, while offering great convenience to shareholders.

Mr. FRANKLIN remarked, that if it could possibly place any class of shareholders at a disadvantage, there would be a reasonable cause for taking time to consider the motion. As it was, he thought there could not be a question, in the minds of business men, on the subject.

After some further explanations from the GOVERNOR, in reply to questions as to the details of the proposed conversions,

The amendment was put to the meeting, and the mover's hand only was held up in its favour.

The motion was put, and carried without a dissentient.

The GOVERNOR: I may now come to the second part of the business for which you are called together—viz., the question of the remuneration of the secretary, Mr. Phillips. And before I give expression to my own opinion, and, I may say, the unanimous opinion of the court, I may as well read to you a minute which was adopted by us at a court of directors, held on April 28, 1876:—"Resolved unanimously, that it be recommended to the court of proprietors, at their next meeting, that the salary of the secretary be increased by £1500 per annum, from the commencement of the scheme for the amalgamation of the Imperial Gaslight and Coke Company and the Independent Gaslight and Coke Company with this company."

A SHAREHOLDER: What is the present salary of the secretary?

The GOVERNOR: £2000 a year. Many gentlemen, whom I now see here to-day for the first time, may not be as conversant as I and the late governor and the other directors of the Chartered Company are with the merits and the services of our secretary. Mr. Phillips was appointed secretary of the Chartered Company in the year 1863. I well recollect the time, for it so happened that, upon the retirement from office of our late excellent secretary, Mr. Burls, a gentleman who had served the company for very many years most faithfully and zealously, the directors determined upon advertising, as the best possible course to pursue, for candidates to fill that responsible position. I was one of the committee appointed to select from the 65 candidates the persons whom they thought best qualified for the post. At that time the company was in its infancy. Our capital did not exceed £600,000. The result of our scrutiny into the merits of the candidates was that we eliminated the names of 62 gentlemen, and left three for the consideration of the full court. Those three were Mr. Phillips and two brothers of the name of Jebb. The court selected Mr. Phillips, and the Messrs. Jebb, I am happy to know, have succeeded admirably well in the world since then. I am also certain that the shareholders of the Chartered Company and the shareholders of all the other companies which have been absorbed into it, will always have reason to be thankful for the choice we made on that occasion. I am convinced that no man in the world could have so efficiently discharged the important duties of his office as Mr. Phillips has done. It must be taken into consideration, that in utilizing the vast powers of the mind of Mr. Phillips, we have had the advantage of employing a man, who in his early days was brought up in the house of one of the most eminent parliamentary agents in London, where he gained a large amount of information and experience, and great facilities of intercourse with members of different public bodies, with Parliament itself and the officers of the Government, all of which knowledge and experience he has put completely at our disposal. I will venture to say, from my own knowledge, and I am sure my predecessor in the chair will confirm the remark, that Mr. Phillips has saved this company thousands of pounds in parliamentary expenses alone, not only in the drawing up of our bills, but in the great facilities his experience has enabled him to give us in the general conduct of those parliamentary affairs, which have from time to time caused your directors the greatest possible anxiety, and have been the cause of enormous expenditure to the company, with little or no benefit to our undertaking. As I said at the last meeting, we have paid thousands upon thousands of pounds in parliamentary struggles, forced upon us by the oppression of public bodies, like the Corporation of London and the Metropolitan Board, which money, for any benefit to ourselves or to the consumers of gas, might just as well have been thrown into the sea. All those expenses might have been easily avoided if there had been any disposition on the part of the public bodies, as there always was on the part of the company, to make some little concessions. This company, at the present moment, have just fifteen times as large a capital as we had when Mr. Phillips joined us. He was appointed at the modest salary of £600—a sum very much below what he was entitled to; but we thought it better that he should be placed upon a low, but an increasing, salary yearly, for a certain number of years. We soon, however, found his services so valuable that his remuneration was doubled, and it was subsequently increased from time to time till, in 1870, it was £1500, and in 1874 it became £2000, at which sum it still stands. Now, I am very well prepared to hear persons, who are not acquainted with the advantages which Mr. Phillips's association with this company has showered upon the gas world, and really and truly upon the public generally, assert that the proposal now made will give him an excessive salary; but if gentlemen will calmly consider the enormous responsibility attached to the secretarial duties, I am sure they will not hesitate for a moment to confirm the resolution deliberately passed by the court of directors, and which I sincerely trust may be unanimously agreed to by this meeting. I may further mention, as showing the benefits accruing to the company, that, of course, as secretary, Mr. Phillips has a great deal to do with our contracts for coal and other things, which have hitherto been of a very extensive character, and will be still more so; and I have no hesitation in stating that in every instance he has been able to effect very large savings by the admirable manner in which he has managed this department of our business. I think I need not say more respecting Mr. Phillips in asking you to confirm the resolution of the board; but before I sit down I ought to compare Mr. Phillips's salary with that of the secretaries of other undertakings, involving not one tithe of the work and responsibility. In almost every instance (such as the Peninsular and Oriental Steam Company, with their capital of £3,000,000, where there are three managing directors at large salaries, besides secretaries, &c.) the remuneration of the secretaries is larger than in our company. We have a capital now, including borrowing powers, of £10,000,000, every shilling of which we shall have to call up and expend, and I say that in comparison with other companies of similar magnitude to our own (not gas companies, for there is no other gas company half so large as this), the salary of our secretary is by no means excessive. I have, therefore, much pleasure in asking you to confirm the resolution of the court of directors which I have read.

Mr. BECK: It is with considerable inconvenience to myself that I have attended here to-day to second this resolution. I had no hand in passing the minute which you are asked to confirm, because I am not now a member of the court of directors; but when I heard of it, I said I should certainly attend the shareholders meeting and second the confirmation of it, however inconvenient it might be. And I did it, gentlemen, because I feel sure that, however large the amount may appear to some, Mr. Phillips richly deserves it. I have known Mr. Phillips ever since he was appointed secretary, and I unhesitatingly say that if honour, integrity, judgment, and ability constitute qualifications for the office in which he was placed, there is no man in the world more fitted to undertake its duties. But I always try to look at matters in a practical way. The capital of this company is £10,000,000, and the income is nearly £2,500,000. The coals which we consume annually are nearly one million tons. One penny per ton upon the coals we carbonize every year would exceed considerably the amount at which it is proposed to fix the salary. It is a mere bagatelle as compared with the large transactions of the company. No doubt it is a large salary, but the question is, if you have a man whose heart is in his business, and who possesses the ability to carry it on with energy and success, is there any salary, in reason, which can be considered too large for such services? In the position I have had the honour to occupy in this company, I have observed the great tact with which Mr. Phillips has managed the most difficult transactions. You may suppose there was no inconsiderable amount of work connected with the carrying out of our various amalgamations, which was all accomplished by Mr. Phillips under the direction of the court, and his salary is nothing to the saving which he has been able to effect in carrying them through. As I said before, the whole of our contracts every year come before him, and, speaking as I do in the presence of other secretaries, I know that we have made our contracts more favourably on most occasions, particularly during the coal famine, than other companies. It is taking this practical view of the matter that I think it right to second the resolution, which I have great pleasure in doing.

Mr. LIGHTLY SIMPSON: I do not propose to occupy many minutes of your time in supporting the motion, but I wish to say that as the chairman of the late Western Gas Company, I was brought into communication with Mr. Phillips, and I think the singular ability he has displayed in the discharge of his office, and the largeness of his views, should not be lost sight of by the shareholders of this company. I hope the vote to-day, which will give him a remuneration not more than equivalent for his services, will be carried unanimously—gracefully and not grudgingly. I endorse all that the governor has said in reference to the secretary.

Mr. JACKSON said the proposition made by the governor was a very serious one, and demanded the careful consideration of the meeting. No doubt what the governor and the ex-governor had stated was entitled to great weight, but the question, after all, was whether the proposed increase in the secretary's remuneration represented value received by the company. Another question also presented itself to his mind—viz., whether the immense responsibility of the management of £10,000,000 of capital ought to be dependent upon the health and capability of one individual. He hoped the board would give their grave consideration to this point. To his own mind there was no question that Mr. Phillips was entitled to the increased remuneration, and he felt that it represented in no way the increase of responsibility and work which had come upon him. It would, therefore, be infatuation for a single instant to hesitate in accepting the proposal before the meeting, which was submitted on the strong recommendation of the directors, who were so much better than any one else able to judge of the merits of the case, and who themselves also held large stakes in the concern. The income of the company was about half a million net, and for a man of Mr. Phillips's ability and experience, a salary considerably less than one per cent upon the net income was surely not too large He hoped, therefore, it would be carried unanimously.

Mr. SAYWELL opposed the motion, and moved an amendment to adjourn the further consideration of it for 12 months. He thought they should wait and see the result of the amalgamations that had just taken place, and not, as the first-fruits of it, increase their expenditure.

Mr. HARDING seconded the amendment.

The GOVERNOR said Mr. Saywell was in error in supposing that the first result of amalgamation was an increase of the company's expenditure. The fact was that, notwithstanding all the pensions consequent upon retirements since the amalgamations, there would be a saving in the secretarial department of £1250 a year, after the increase now proposed to Mr. Phillips. With regard to what fell from Mr. Jackson as to the large responsibility resting upon one individual in the management of the company, he might state that the honourable proprietor was entirely unacquainted with the system upon which their

financial business was conducted—a general sketch of which he gave, showing that, in this matter, Mr. Phillips had not such a perilous responsibility upon him in connexion with it as was supposed.

Mr. DOANE said he was much obliged to the governor for giving these explanations, because it was desirable the shareholders should know and feel that, after all, the responsibility of conducting the company's affairs rested with the directors. In reference to the motion, he asked why, if the secretary's remuneration was increased, they should not also increase that of the chief engineer.

The GOVERNOR said the company had no engineer-in-chief; but with reference to the remuneration of other officers, the question had been considered by the board, and every officer whose duties had been increased had been proportionately compensated to his own entire satisfaction.

Sir C. BLUNT, notwithstanding the objection raised by Mr. Saywell, would support the motion, but wished to know whether, in addition to the increase of £1500, there would be an advance in the secretary's salary from year to year.

The GOVERNOR said the amount of remuneration was not put upon an increasing scale; but he would not say that at some future period the question would not have to be reconsidered with that view.

Mr. S. WARD felt it his duty to support the board, believing they had fully considered the matter; but he confessed that he was surprised at the largeness of the proposed increase.

The amendment was then put to a show of hands, and lost; whereupon Mr. Saywell demanded a poll, and some conversation arose in reference to it; but it was ultimately abandoned.

Mr. FRANKLIN moved another amendment, to the effect that instead of the sum named by the board, the increase be only £1000 a year.

Mr. FIELD seconded the amendment.

On a show of hands the amendment was negatived by 57 to 40.

The original motion was put and carried by a large majority.

A vote of thanks was then passed to the governor, deputy-governor, and directors.

The GOVERNOR acknowledged the vote, and the proceedings terminated.

MONTE VIDEO GAS COMPANY, LIMITED.

The Ordinary General Meeting of Shareholders was held at the City Terminus Hotel, Cannon Street, London, on Wednesday, the 10th inst.—J. BRAMLEY-MOORE, Esq., in the chair.

The SECRETARY (Mr. J. T. Denniston) read the notice convening the meeting, and the following report and statements of account were presented:—

The directors have to report to the shareholders upon the general working of the company for the year 1875, and to submit the accompanying statement of accounts to the 31st of December last. The balance to the credit of profit and loss at the end of the year, after allowing for bad and doubtful debts and depreciation of stock of fittings, is £39,385 2s. 8d.

The directors have transferred the sum of £6250 to contingency-fund, thus raising the balance of this account to £16,000. An available balance of £33,135 2s. 8d. thus remains, representing sufficient for a dividend of 6 per cent. on the paid-up capital of the company, being a reduction on the rate of dividend hitherto distributed, which is rendered necessary by the exceptional circumstances of the year.

Owing to the delays in remittances, caused by the difficulty of collecting the company's funds under the exceptional monetary crisis at Monte Video, the directors have been unable to pay an interim dividend during the year. They are not yet prepared for an immediate distribution, but they propose to call a special general meeting, as soon as practicable, for the purpose of dealing with the profits unappropriated at this date.

The dock is now completed, and the directors, having obtained a duly authenticated certificate of survey by a competent engineer, have relieved Viscount Mauá from all his obligations to the company. With the object of increasing the revenue of the dock, the directors deemed it advisable to extend it beyond the length originally constructed, and so to alter the internal arrangements as to admit vessels of a larger class than hitherto, including steamers navigating the river Plate. This they have been enabled to accomplish with successful results by availing themselves of the land granted to the company by the Viscount. These important alterations have entailed an expenditure of £5750 18s. 7d. on capital account, and the directors believe that the value of the dock, as completed, is increased considerably beyond the cost of the additional work executed.

The new gasholder will be available for the storeage of gas at the commencement of the coming winter, and it now only requires the connexions with the works to be completed. This important addition to the plant of the company, including the purchase of land, cost at the end of 1874, £7302 15s. 11d., and during 1875, £13,633 1s. 4d.

In reviewing the past year, which has been a period of trouble and anxiety to the directors, they feel, while regretting the necessity for the postponement of the dividend, that they may fairly congratulate their fellow-shareholders on the soundness of the company, and on the fact that the direct loss sustained has not been serious. It is, moreover, encouraging to note that the demand for gas has increased over previous years; the low price of coal continues also to be an element in favour of the company; and the directors look forward to the future with confidence.

The directors who retire by rotation are John Bramley-Moore, Esq., and Frederick Youle, Esq., who, being eligible, offer themselves for re-election. The auditors, Messrs. Price, Waterhouse, and Co., and John Cater, Esq., retire, and offer themselves for re-election.

Balance-Sheet, Dec. 31, 1875.

Dr.				*Cr.*			
Capital authorized—				Capital expenditure—			
30,000 shares of £20 each		£600,000	0 0	Cost of gas-works, mains, concession, dock, plant, & sundries, as per balance-sheet, Dec. 31, 1874		£506,490 14 4	
2,904 shares unissued		58,080	0 0	Add expenditure in extension of mains, enlargement of the retort-houses, purifiers, &c., during the year ending this date		3,989 8 4	
27,096 shares of £20 each, fully paid, issued to date		541,920	0 0	Extension of dock		5,750 18 7	
Sundry creditors, London and Monte Video		9,900	14 9	Iron coal lighter		69 6 9	
Contingency-fund		16,000	0 0	Expenditure on new station and gasholder		13,633 1 4	
Dividends unclaimed		91	12 0	Stock of coals at cost		9,676 12 8	
Profit and loss account—				Ditto residuary products		618 10 3	
Balance brought from last year	£20,790 1 4			Ditto gas-fittings		10,121 19 8	
Net profit, present year	39,433 9 4			Meters		5,368 8 7	
	£60,223 10 8			Sundry stores		1,652 15 7	
Ded. dividend paid Sept. 29, 1875	20,838 8 0			Furniture in London and Monte Video		807 17 7	
Balance	39,385 2 8			Sundry debtors, being gas consumers in Monte Video		13,313 10 11	
Less carried to contingency-fund	6,250 0 0			Goods for shipment and afloat		159 5 10	
Balance carried down		33,135	2 8	Bills receivable in Monte Video		17,881 19 2	
				Bills receivable in transit		8,100 0 0	
				Cash in London and in hand		2,073 19 6	
				Ditto in Monte Video		1,347 19 4	
		£601,047	9 5			£601,047	9 5

Profit and Loss Account for the Year 1875.

Cost of manufacture and expenses in Monte Video		£61,124	17 3	Sale of gas, residuary products, rent of meters, and sale of gas-fittings, &c.		£101,236	8 0
Directors fees, salaries, and London office expenses		2,661	19 3	Dock revenue		6,273	12 10
Interests on loans and discounts		181	12 9	Iron lighter		257	2 0
Income-tax		392	16 8	Gains on exchange		358	0 10
Bad debts written off		2,319	1 7	Interest received		136	3 4
Depreciation in stock of fittings		2,425	10 8	Commission on freights		242	4 0
Balance, being profit for the year		39,433	9 4	Transfer fees		28	10 0
				Bad debts recovered		7	6 6
		£108,539	7 6			£108,539	7 6

The CHAIRMAN said the duty now devolved upon him—and he regretted very much that the task was not in abler hands—to be the exponent of the affairs of the company on this occasion. He met them with great pleasure as men of business, for though he had nothing very flattering to tell them, and rather a disagreeable thing to announce—viz., that the dividend was reduced from 8 to 6 per cent., still he felt assured that the report presented would meet with approbation and support. They were all aware of the frightful state of things that had prevailed in Monte Video for some time past. The revolutions and changes that had of late taken place in Monte Video had annihilated and destroyed all trade; in fact, so much so that the inhabitants had been compelled to leave the town in large numbers, and take up their abodes in the country. Consequently, the shareholders of this company must be prepared in part to suffer with the rest of the community. Still, taking all matters into consideration, he thought they would arrive at the opinion that their affairs might be viewed in a more favourable light than for some time past. And when he called their attention to the condition of the company, and to the improved position in which the directors were striving to place it, they would cheerfully and willingly sanction a reduction of the dividend on the present occasion. The financial crisis in Monte Video had spread through every class of society, and, in fact, no one escaped from being affected by it, whether commercial or independent men—all had alike to suffer, no matter in what pursuit they were engaged. But he had the pleasure to inform the meeting that matters had of late assumed a more settled state, and that amicable relations had been entered into with Brazil—a matter of the utmost importance to the welfare of the Uruguay country. When that country was in friendly relations with Brazil, matters would quickly resume their normal course, and prosperity would soon return. The best thing that could happen for Monte Video would be for it to unite and throw in its lot with the great Brazilian empire, whether for weal or woe. They would then see the field of emigration multiplied, and a prosperity dawn upon the country heretofore unknown. He might state also that the prospects of the harvest were exceedingly good, and that circumstance alone was a great element in the future prosperity of the company. The directors had endeavoured to give the shareholders as complete an analysis of the position of the company as could well be compressed into the compass of an ordinary report, like the one which they had presented to the meeting; but if any points required further elucidation, he would be very happy to give all the information in his power and in that of the directors and officers of the company. It would be seen that the board, amongst other things, had made a large reduction in the value of the fittings, some of which had become old, and were not in accordance with the tastes of the times. They had also effected large reductions in the economy of the establishment, and had had to lay out considerable sums of money in the purchase of land and other matters, which were fully explained in the accounts in the possession of the shareholders. If they had not written off for depreciation and bad debts the sum of £4744, they would have had much more to the credit of the company; but they considered it the proper course to adopt, and, as practical mercantile men, they thought it best to take the "bull by the horns," and put everything on such a footing that they would have nothing to fear in the future. This would account for a very large item. They had also to incur very considerable expense in moving the premises, which were not at all adapted for the purposes of their fittings business. The new gasholder which the shareholders were informed, at the last meeting, that the directors had resolved to construct, and which was then actually in the course of construction, was almost completed, and would come into operation in good time for the winter season which was now commencing. He then came to the most important matter, and that was the dock question. He was happy to state that that was now finally settled, and the directors had received a certificate from the engineer that everything had been satisfactorily completed. In dealing with this question, the board had had great difficulties to contend with, and they were much indebted to the Viscount Mauá for the assistance rendered to them in overcoming these difficulties. The Viscount had had to spend a large sum of money in bringing about the completion of the docks, and he (the chairman) believed he was about the mark when he said that the Viscount had expended £40,000 personally upon the work. The directors had had to purchase land to elongate the dock to the extent of 50 feet. It was now 268 feet in length, and would prove of great advantage to the company. Referring to the financial part of the report, the chairman remarked that the necessary reduction of dividend on the present occasion from 8 to 6 per cent. was, of course, not an agreeable thing; but, under all the circumstances, he trusted the shareholders would be reconciled to receive it, in the hope of an improvement soon taking place. Things were now working round, and he thought they might look forward to greater regularity in their dividends than hitherto. Since the publication of the report, the directors had received a telegram from Monte Video to the following effect:—"Matters in order at the company's office. Every penny Government and public department owing up to 31st March received. Remittances £20,000 made to-day. Increase in light-tax promised a few days hence." That telegram was received on the 4th of May. He thought, therefore, they might infer that £20,000 available for dividend was now on its way to this country, and that that amount would probably be received in the course of the next three weeks. If the shareholders would pass a resolution authorizing the directors to pay 6 per cent. out of that amount, it would not be necessary to call them together again formally for the purpose of declaring a dividend to the end of last year. He could not close his remarks without referring to the obligations the company were under to the Viscount Mauá. They owed, indeed, the whole of their success to his influence and exertions, and he was sure the shareholders would join with the directors in acknowledging the services he had rendered in promoting the success of the undertaking.

Mr. YOULE seconded the motion.

Mr. MICHOLLS remarked that he could not bring his mind to see how the affiliation of a dock to a gas company was a thing to be desired. The energies of the *employés* of a gas company ought to be directed to economy and efficiency in the conduct of the establishment, the purchase of material, and the manufacture and distribution of gas, and not to such extraneous matters as docks and shipping. Then as to the outlay; the dock was constructed at a time when iron was dear, and when the company were in a struggling condition as to money matters, so that, in his opinion, it had better not have been undertaken. He suggested that it would be better to try and dispose of that part of the undertaking.

Mr. JAMES said the last speaker must be aware that when he bought his shares the dock was a part of that in which he invested his money.

A SHAREHOLDER said he thought the dock was at present yielding a better profit than the gas-works.

Several questions having been put—

The CHAIRMAN replied. With reference to the dock, he remarked that it formed a part and parcel of the original undertaking, and it was one of the most important adjuncts to the gas-works the company could possibly possess. If they had no dock they would have to pay, in lighterage, a very considerable sum every year. In a place like Monte Video, subject to periodical storms, too high a value could hardly be set upon the possession of dock property. Already the income from it was large, and there could be no reasonable doubt that it would become much larger, independent of its advantages in the operations of the gas-works. Questions had been asked about differences which appeared, upon a comparison, between the accounts for 1874 and those for 1875. As to residuals, the difference in receipts arose from the fact that in 1875 there was not the same demand for coke in consequence of the lime kilns being stopped. As to fittings, when the company took possession of the undertaking, they did

not exactly know what they had handed to them, in the shape of stock of gas-fittings. The directors therefore ordered an exact return to be made, and a valuation put upon them, based upon an estimate of what they were worth at the time. Certain sums were then written off for depreciation, as it would have been unwise to put down things at their original cost, when they knew they would not produce anything like that amount in the market. In answer to another inquiry, he remarked that the directors had the power to cut off the gas of consumers who were in arrears, but it was necessary to exercise that power with prudence, so as not to imperil the recovery of the debt due to them. The whole of the property in the gas-works and dock was the freehold of the company. The present concession had about 12 years to run, and he had the satisfaction to tell the shareholders that arrangements for a considerable extension of the concession were in progress. If that was obtained they would again be under obligations to the Viscount Mauá. But even if they did not get it, no one would be able to come in and compete with the company after the present concession expired. The expenditure on the "new station" consisted of new gasholder and freight, £6000; cost of land, and excavations and erections, made up the amount to £20,000.

The motion was then put and carried.

The SECRETARY read a comparative statement of management and other expenses for two or three years, in reply to a question by a shareholder, as to an increase in directors fees, &c.

On the motion of Mr. DE SALLIS, seconded by Mr. JAMES, the retiring directors were re-elected.

A SHAREHOLDER inquired whether the directors were satisfied with their present manager at Monte Video.

The CHAIRMAN declined to answer, and said he would not permit any discussion of the conduct of an official in a meeting of shareholders. That was a matter which belonged entirely to the executive. If any question required to be brought before the shareholders, the directors would not shrink from doing it, and giving the fullest information.

The retiring auditors having been re-elected,

A formal resolution authorizing the payment of the dividend recommended when the directors are in possession of the necessary funds, was then adopted, and

Thanks to the chairman and directors terminated the business.

M. GIROUD'S "GAS VERIFIER."

[From *Le Gaz.*]

Although we are already indebted to the indefatigable researches of M. Giroud for a number of very ingeniously contrived apparatus of unquestionable utility in gas industry—such as station-governors, lamp regulators, rheometers, &c.—that gentleman has still further increased the list by the addition thereto of an apparatus, recently contrived by him, for testing the illuminating power of gas, to which he has given the name of the "Vérificateur," and which he intends to supersede the photometers at present in use.

An easy and sufficiently exact estimation of the quality of gas, as far as regards its illuminating power, has become a matter of primary importance. The scientific solution of the question is very completely obtained by means of the photometric apparatus of MM. Dumas and Regnault; that instrument is, however, expensive, large in size, and requires for its manipulation a skilful operator and numerous precautions. Its daily use in small gas-works has, therefore, been attended with some difficulty. Several empirical means for instructing managers of gas-works have also been tried, among which we may mention Lowe's jet photometer and Schilling's apparatus.

It has been for some time observed that in the case of coal gas the variations in the lighting power ordinarily correspond, other things being equal, to the variations in the height of the flame, and that the latter is so much larger in proportion as the intensity of the illuminating power is greater. In Lowe's jet photometer this law is utilized by causing the gas to be consumed at a candle burner under a constant pressure; the height of the flame is observed, and from that the lighting power is deduced, with a certain approximation, by means of tables arranged for the apparatus. The point neglected in Lowe's jet photometer is the volume of gas consumed to obtain the height of flame observed.

In Schilling's apparatus the density of the gas is sought for by the known law of the flow of gas in pipes, and the illuminating power is generally so much higher in proportion to its greater density. Some indication is thus obtained of the value of the gas manufactured.

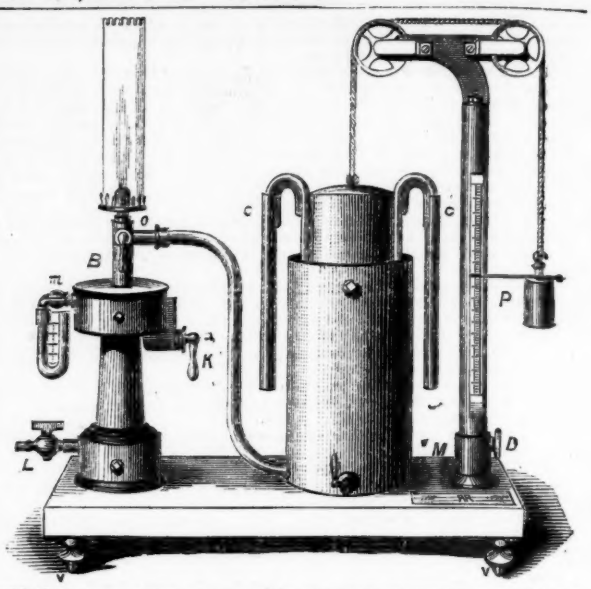
M. Giroud's "Verifier" not only gives ordinarily correct indications, but takes account of the two elements to be considered, enabling gas managers to ascertain the quality of their gas in a very exact and simple manner by fixing the height of the flame, and by ascertaining the consumption necessary to obtain that flame. We have ascertained by numerous experiments, that with the standard gas of Paris, an expenditure of 38 litres (1·35 cubic feet) per hour gives, with a candle burner having a hole about a millimètre in capacity,* a flame 105 millimètres (4 inches) in height, which corresponds to the light of one candle. That is the standard of unity adopted for the "Verifier." The gas will, therefore, conform to the Paris standard whenever this expenditure of 38 litres takes place, it will be below that quality when the expenditure is more than 38 litres, and above it when less than that quantity is consumed.

Description of the "Verifier."—The apparatus is composed of a photo-rheometer, regulated to a consumption of 38 litres of gas of the Paris standard, and of a gasometer intended for measuring the quantity of gas consumed by the photo-rheometer in the space of one minute, when, with a candle burner having an orifice of about one millimètre, a flame 105 millimètres in height is produced. The gasometer is balanced by a counterweight, P, so that it may rise under a pressure of from 10 to 15 millimètres (4-10ths to 6-10ths), and by compensators, C C, which maintain constant the weight of the immersed portion of the gasometer, and at the same time ensure the invariability of the water-level in all positions of immersion. The weight, P, carries a horizontal needle sliding upon a scale graduated in millimètres, and attached to a ratchet bar, actuated by the button, D.

It is advisable to leave the jet of the photo-rheometer always burning, so that the apparatus may be ready for action without the danger of a small quantity of air becoming mixed with the gas. The flame is protected by a glass chimney, partially blackened on the inner side, in order to avoid reflection; it has two lines marked upon it, at the distance of 105 millimètres from each other. The lower line should be brought to the level of the orifice of the burner by raising or lowering the gallery which supports the chimney. This gallery is then fixed by means of the screw O. It is not necessary to raise the metallic webbing placed upon the chimney, in order to light the burner.

Having made the stand of the instrument perfectly horizontal, by means of the screws V V, and provided the two chambers of the photorheometer with glycerine, and the lower chamber of the gasometer with water up to the levelling-screws, the operator should draw out the air by means of the orifices placed at the upper part of the compensators, C C, until he has charged the small syphons supporting these compensators. This operation has to be repeated each time the gasholder is taken entirely out of water. The apparatus is then ready for action.

The gas enters at L, and passes on to be consumed at the burner so long as the stop-cock B is in the position indicated in the engraving; but when the handle is turned to an angle of 90 degrees in the direction of the pipe communicating



with the gasometer, the gas gauged by the photo-rheometer passes into the gasometer instead of burning at the jet.

Method of Conducting an Experiment.—In order to test a gas, the operator should first light the burner, and then notice whether the flame is 105 millimètres in height; if higher than that, it should be reduced by closing the stop-cock L; if lower, it should be increased by opening the stop-cock K. The requisite height having been obtained, a small quantity of gas is passed into the gasometer to float it, by raising the handle B horizontally to the right, restoring it to its original position as soon as the gasometer has risen about a centimètre. The zero point on the scale should then be brought under the needle by means of the button D, and the apparatus is ready.

All that is required now is, to send the gas into the gasometer by turning the handle B quickly with one hand, and at precisely the same moment starting a minute-clock with the other. At the expiration of one minute the handle B should be sharply restored to its original position. It now only remains to read off the division on the scale at the point where the needle, P, has stopped, which indicates the height to which the gasometer has risen. If the needle indicates 127 millimètres (5 inches), the gas is equal to the standard gas of Paris; if less than 127 millimètres, it is of better quality; if more, it is of inferior quality.*

E is a stop-cock for emptying the gasometer after each experiment; M is another for emptying the water chamber. The stop-cock *m* in the manometer should always be left closed.

Before commencing an experiment the operator should satisfy himself that the pressure of the gas entering at L is at least 30 millimètres (12-10ths.)

All the foregoing remarks refer to the standard gas of Paris, which, when burned at the rate of 105 litres (3·7 cubic feet) per hour, gives a light of 7½ candles. But if, owing to the conditions of some contract, the same illuminating power has to be obtained in certain localities, with a different quantity of gas, the expenditure of this gas, corresponding to one candle, or to the flame of 105 millimètres of the apparatus, would be obtained by multiplying by 38 the number of litres stipulated for, and dividing the product by 105. As a movement to the extent of 127 millimètres by the gasometer corresponds to 38 litres, it is easy to ascertain the number of millimètres the gasometer should rise for the quality of gas prescribed in this case.

The following example will show the method of deducing from one observation the illuminating power of a gas. Let us suppose that the operations have been carried out as previously indicated, and that the gasometer has risen to 124 millimètres. We know that 127 millimètres correspond to 38 litres consumption per hour at the burner; one millimètre will therefore correspond to $38 \div 127$, and 124 millimètres to $124 \times 38 \div 127$, which works out to a consumption of 37·1 litres. If 127 millimètres were not the number corresponding to 38 litres, it would be necessary to substitute for it, in the preceding calculation, the number marked for each apparatus.

It will be seen that the foregoing calculation is only an investigation into the actual capacity of the gasometer, and serves to establish the table of consumption corresponding to the divisions of the scale for each gasometer.

By the aid of this instrument the illuminating power may also be ascertained by making, by the skilful handling of the stop-cock K, the consumption equal to 38 litres, and then measuring the height of the flame; but this process is not so simple, and less convenient for practical purposes.

* It seems at first sight that the diameter of the hole is an essential element to be considered; but in this apparatus it is not so, since the amount of gas consumed is regulated by the photo-rheometer, independently of the burner employed.

* Each instrument is marked with the number of millimètres which the gasometer should rise, in order that the expenditure of gas should correspond to 38 litres; this number may vary from 126 to 128 millimètres.

BAHIA GAS COMPANY, LIMITED.

The Ordinary Half-Yearly General Meeting of Shareholders was held at the Company's Offices, Coleman Street, London, on Tuesday, the 16th inst.—ARTHUR J. KING, Esq., in the chair.

The SECRETARY (Mr. A. J. Head) read the notice convening the meeting, and the following report and statements of account were presented:—

The statement of accounts for the half year ending Dec. 31, 1875, now submitted, shows the improvement anticipated by the last report. The cost of coals has materially decreased, while the revenue from gas and products has advanced; and notwithstanding the continued heavy expenditure for works, and the large amount of bad debts and allowances, the profit for the half year is £3393 6s. 4d.

The directors are happy to state that the Government has paid the balance of the award of arbitration.

The jetty has been completed; a new scrubber has been sent out; 42 additional public lamps have been erected; and other works of improvement are in progress.

There is, however, considerable further expenditure to be made before the works will be in an efficient condition, the most important being an improved system of mains, as recommended by the company's engineer, at an estimated cost of £9000. This work will be commenced as speedily as possible.

The profits for the half year, £3393 6s. 4d., added to the balance of £1183 2s. 3d. brought forward, makes the sum of £4576 8s. 7d.; out of which the directors have carried the sum of £1000 to form a reserve-fund, and recommend the payment of the preference dividends of 10 and 7½ per cent. respectively for the half year, and that a dividend at the rate of 2 per cent. per annum be paid on the ordinary shares. This will absorb £3125, leaving £451 8s. 7d. to be carried forward.

Since the last meeting Mr. J. B. Paddon and Mr. J. Brickwell have retired from the board. The directors have elected Mr. Edward Horner and Mr. Henry Finlay to fill the vacancies. It devolves on the shareholders at the meeting to confirm these elections.

Balance-Sheet, Dec. 31, 1875.

Dr.				*Cr.*			
Capital—				Concession		£7,000	0 0
5000 ordinary shares	£190,000	0	0	Investment to June 30, 1875		93,561	12 0
1000 10 per ct. preference shares	20,000	0	0	Additional during half year		2,059	11 11
1500 7½ ditto ditto	30,000	0	0	Meters fixed		4,705	2 7
Creditors—				Office furniture and fixtures at Bahia and in London		3,114	6 6
On open accounts	1,088	7	8	Preliminary expenses		429	8 3
On acceptances	1,973	18	9	Suspense account—		16,914	17 3
Insurance-fund	47	4	10	Extension of retort-house, &c.		3,757	8 10
Reserve-fund	1,000	0	0	Amounts due for gas, fittings, &c.—			
Profit and loss	3,576	8	7	Public lamps		3,013	15 4
				Ditto establishments		3,806	6 7
				Private rental, fittings, and coke		5,533	6 3
				Sundry debtors		496	10 6
				Stock—			
				Coals		3,992	11 0
				Turba		166	1 5
				Coke		26	4 3
				Fittings		4,125	19 2
				Mains, lamp-columns, and other materials		1,574	13 0
				Goods in transit		641	7 8
				Bills receivable		1,500	0 0
				Cash at bankers—			
				General account		436	3 2
				Bahia		499	1 6
				London office		7	0 0
				Bahia office		333	12 8
	£157,685	19	10			£157,685	19 10

Revenue Account, for the Six Months ending Dec. 31, 1875.

Coals carbonized	£6,717	2	7	Gas supplied to—			
Purifying materials	199	2	6	Public lamps	£9,321	6	7
Carbonizing wages	1,272	18	1	Less fines	333	7	2
Lamplighters wages	815	1	3		£8,987	19	5
Yardmen, labourers, &c.	594	3	6				
Salaries	1,941	19	4	Private consumers	6,778	18	9
Directors fees	400	0	0	Public establishments	1,442	14	2
Auditors fees	21	0	0	Meter-rental	518	14	1
Rent, taxes, and insurance	196	3	0	Products	1,813	13	6
Interest	240	10	10	Transfer fees	1	11	0
Stationery	62	14	5	Profit on fittings	525	18	3
Office expenses	64	10	4	Bad debts recovered	8	9	5
Keep of horses	80	5	7				
Trade charges	307	0	11				
Wear and tear	1,068	10	0				
Repairs and maintenance of public lamps	540	18	6				
Repairs, &c., mains and services	472	5	9				
Travelling expenses	34	0	2				
Bad debts and allowances	491	16	2				
Exchange (loss)	70	19	1				
Law charges	42	12	4				
Extraordinary disbursements—							
Extension of retort-house, &c.—⅓ of £2121 11s. 5d. (3rd instalment)	658	11	11				
One-sixth of £1078 19s. 6d. (2nd instalment)	179	16	7				
One-sixth of £1274 16s. 3d. (1st instalment)	212	9	5				
Balance—profit	3,393	6	4				
	£20,077	18	7		£20,077	18	7

Profit and Loss Account, for the Half Year ending Dec. 31, 1875.

Reserve-fund	£1,000	0	0	Balance of account to June 30, 1875	£1,183	2	3
Balance	3,576	8	7	Revenue account, net profit for the half year ending Dec. 31	3,393	6	4
	£4,576	8	7		£4,576	8	7
				Balance brought down	£3,576	8	7

The CHAIRMAN: Gentlemen, as our business depends upon the conversion of coal into gas, the most important item of comparison in our accounts will be the cost of coal and the amount received for gas. The accounts for the last half year show that for every £1 spent in coal we received £2 11s. 3d. in gas, as against £1 10s. 9d. for the half year to December, 1874, and against £2 for the half year to June, 1875. This shows a most satisfactory and substantial advance, and I may say there is every reason to expect that the accounts for the half year now current will show a further improvement. I hope we may succeed in getting up to £3. Any further progress in rental per ton beyond that must be looked for, not in improvements in manufacture, for these have almost reached the limits of possibility, but must come from reductions in the cost of coal, or an improved system of distribution. The leakage must be reduced, and it is in that direction we must mainly look for improvements under this item. The next point of comparison will be the gas-rental. If you look at the item of public lamps, you will see that during the past half year we received £8987, as against £7896 in the corresponding period of the previous year. The private consumers rental, which stood at £5594, now stands at £6778, being an increase of 20 per cent. in 12 months, which is very satisfactory. The rental from public establishments, which stood at £1209, now stands at £1442. The total gas-rental last half year was £17,209, as against £14,700 in the corresponding half of the previous year. I therefore submit to you that, taking these two items alone into review, the results are such that we may fairly congratulate the shareholders upon the progress exhibited. Now, in regard to the various items on the debit side of the revenue account, I shall be happy to answer any questions that may suggest themselves to your minds; but it does not occur to me that it is at all necessary for me to take up your time with any observations upon them, as there is no material alteration between this year's account and last. The extraordinary disbursements, which stood at £2336, now stand at £1050. Upon the credit side I may refer to the products which during the last half year amounted to £1813, or about 27 per cent. of the cost of the coals. This time last year we only got 17 per cent., and six months ago 21 per cent.; so that the same rate of progress that is found in the gas consumption and the rental, is also found in the return for residual products. Then we come to the balance of profits, which stands at £3393, as against a debit balance this time last year of £1452. Adding these two sums together, it shows a difference in favour of this year of no less than £4745. I think, therefore, as I said before, I may fairly congratulate the shareholders upon a very marked progress in our affairs. Now, although it is very pleasant for me, as representing the board on this occasion, to state these facts, I do not intend to indulge in any glorification of the existing board. These results have been brought about, first, by the improvements and extensions in the retort-house, which were initiated by our predecessors; secondly, by the more favourable terms on which we have obtained our coals: and thirdly, by the very good management on the other side by Mr. Muriel. Taking now the balance-sheet, if you compare the present with the one for the half year ending December, 1874, you will find that the amount owing by us to creditors on open account and on acceptances, which then stood at £11,160, now stands at £3062. There was also at the previous period an account of £5420 for shares pending redemption. That has all been paid off, and our indebtedness reduced from £11,160 to £3062. I think this indicates a very healthy condition of finances. I may also refer to the credit side of the account, where you will find cash at the bankers and in hand £1266, and bills receivable £1500, giving a total of £2766 as against our total indebtedness of £3062, and showing that the latter exceeds the former by only £296. Then further we have stocks £9885; amounts due by sundry debtors, £12,849. After apologizing for the absence of some of the directors on parliamentary business, the chairman proceeded to refer to the changes which had taken place at the board since the last meeting. The vacancies caused by the retirement of Mr. Paddon and Mr. Brickwell had been filled up by the appointment of Mr. Horner, of the Phœnix, and Mr. Finlay, of the Surrey Consumers Gas Companies, which appointments would be brought before the shareholders at a subsequent part of the meeting for confirmation. Much as he and his colleagues regretted the retirement of so able a man as Mr. Paddon, they felt that they had taken the best course in their power in the appointments they had made, and he trusted the shareholders would ratify their decision. He concluded by moving the adoption of the report.

Mr. LINGING seconded the motion.

Mr. H. P. STEPHENSON said he was much obliged to the chairman for the very lucid explanation he had given, and which had anticipated two or three questions he intended to have put. There was now only one point on which he asked for information. He saw by the report that there was to be an improved system of mains laid down, at an estimated cost of £9000. Knowing, as he did, that the existing mains in Bahia were very small, he had no doubt the directors had exercised a fair discretion in the course they were about to pursue; but what he wished to know was, where the £9000 was to be found? Were the directors going to spend the money at once (which, if the work was necessary, certainly ought to be done) or were they going to spread the expenditure over four or five years, taking a portion out of revenue each year for the purpose, which he clearly thought would not be the right course? Probably, if the work was done at once, the company would reap immediate benefits from it, and he would ask the board whether they would issue debentures at a small discount, and bearing a moderate interest, spread over five or six years, and redeemable by sums taken from revenue annually for the purpose. He, with the chairman, regretted very much the retirement of Mr. Paddon from the board, where he had hoped to see him many years, and where his practical knowledge and ability would have been of such great service to the company. But, the retirement having taken place, he congratulated the board on the way in which the vacancy had been filled up.

Mr. J. AIRD, having a knowledge of the condition of the works in Bahia, particularly with reference to the size of the mains, felt sure that the directors, in their proposed new system of mains, were dealing with a point which, above all others, would tend to increase the prosperity of the company. He thought it would take but a very short time, after the arrangement was carried out, to prove to the shareholders that the conclusion at which the board had arrived was a sound and good one. He entirely coincided with Mr. Stephenson in the views expressed by that gentleman, that, to make the benefit thorough and complete, the work should be done at once, instead of in small and detached sections. He was quite sure the directors would be guided by the means at their disposal in dealing with a question of that sort; but if it could be arranged in the larger and bolder form, it would clearly be the more beneficial. He thought he might say, in addition, how very pleased, personally, he felt at the satisfactory report the directors had placed before the meeting that day. The stride that had been made in the improvement of affairs was very great, and if only maintained in the future, the position of the company would be extremely satisfactory to all the shareholders. From the commencement of the company he had had but one opinion, and that was that it had in it the element of success, and if the opportunities it possessed had been more fortunately used, the state of affairs would have been very different. There were still some favourable features to be developed, and, under the able management lately shown by the board, he was encouraged to hope that the shareholders would get that fair return on the capital embarked which they had a right to expect. With respect to the board itself, he could only say that, while deeply regretting the retirement of Mr. Paddon, whose connexion with any company of this kind was an element of strength, he fully appreciated the wisdom of the arrangement made for filling up the vacancy among the directors.

Mr. PADDON said he could not very well allow the many courteous and kind expressions made in reference to himself to pass by without acknowledgment. The accounts seemed to him to need no remark whatever, else he would have been glad to come forward to give the board that support to which they were so well entitled, and, therefore, he might say that his strongest reason for being present at the meeting was that he might answer any questions put to him in reference to his late retirement from the board. He should be very sorry indeed if, on the one hand, that retirement was put down to personal caprice, or to any ill will to those members of the board who still continued. It was a matter alike honourable to both sides, and it might be briefly explained in this way. During the time he had the honour to preside over the company, he endeavoured to make himself as intimate with all its circumstances as possible, and the result was that he took up very decided opinions with reference to certain matters, and after having endeavoured to put those opinions before his colleagues, so as to induce them to share those opinions with him, he found that he could not succeed in doing so. And as he conceived that the progress of a company like this materially depended upon concerted action among the directors, he did not believe that his presence at the board would be further advantageous to the shareholders. He, therefore, notwithstanding the most flattering pressure put upon him by his colleagues, had felt compelled to take the course he had done. But he wished it to be distinctly understood that there was no reason for the slightest censure or reproach to those who differed with him. He never was more strongly confirmed in any opinion that he was right than he was now, because his retirement had paved the way for persons of very high position, and persons who could not fail to be extensively useful to the undertaking. He congratulated the board on having secured a decided advantage by the change, and he sincerely trusted that the affairs of the company would exhibit increased prosperity.

The CHAIRMAN expressed his satisfaction on hearing the courteous and gentlemanly remarks made by Mr. Paddon, and said he could corroborate all that that gentleman had said. Much as the directors regretted the retirement of Mr. Paddon, he was happy to say there had never for a moment been any interruption in the feelings of goodwill and confidence between them and their late colleague, only they felt bound to claim for themselves what they accorded to him—a free exercise of independent judgment. In reply to the inquiry made by Mr. Stephenson as to the expenditure upon new mains, he might state that the directors had written to Mr. Muriel to know whether he could carry out the works himself, or would require help from England. Mr. Muriel answered that he had all the help needed on the spot, and the directors had accordingly written to him again with instructions to carry out the new system with as little delay as possible. But, however fast the work proceeded, it would take time—probably two years—to complete, and therefore the whole of the money would not be wanted for the present, and if wanted at all the directors knew where to obtain it temporarily. With regard to the repayments of any such loan, the figures to which he had alluded showed that the company were comfortably situated with regard to capital, and with the whole amount of indebtedness covered by cash, within £300, and stock and debtors amounting to £23,000, it was clear that

neither the capital nor credit of the company was exhausted. He was not without hope, therefore, that the alterations might be effected without applying for any more capital. At present, however, he was not able to say anything very definitely, inasmuch as the question had not been decided upon by the board. They were able on this occasion to recommend the payment of dividends on the preference shares, which had been in abeyance, and also a small dividend on the ordinary shares. Next year they hoped to put before the meeting still more favourable accounts, and then, if necessary, the shareholders would be more disposed to put their hands in their pockets.

The motion was put, and carried unanimously.

The CHAIRMAN moved a formal resolution declaring the dividends recommended in the report.

Mr. A. CLARKE seconded the motion, which was put and carried.

Mr. LINGING moved, and Mr. GUYATT seconded, the confirmation of the appointment of Mr. Edward Horner as a director.

The motion was put and carried unanimously.

On the motion of Mr. LINGING, seconded by Mr. MAGNUS OHREN, the appointment of Mr. Henry Finlay, as a director, was approved and confirmed.

A vote of thanks to the chairman and directors terminated the business.

WEST OF SCOTLAND ASSOCIATION OF GAS MANAGERS.

(*Continued from page 735.*)

Mr. MARTIN (Kilmalcolm) read the following paper on

DEPOSIT OF CARBON AND CHOKED ASCENSION-PIPES.

The subject of my paper to-day—the deposit of carbon in retorts, and stoppages in ascension-pipes—is one which cannot receive too much attention from gas managers. The accumulation of carbon as an incrustation on the inside of retorts has been a sure crop for many years, and in a good many works at the present day the only remedy employed is the old-fashioned one, of simply chipping it off with a crow-bar. You are all aware that this process greatly injures the retorts, and in many cases completely destroys them; but we still cling to our old habit of removing the carbon, simply, I fancy, because it was the custom formerly. Now, this is not creditable to us. Let us endeavour to find out, if possible, what is the cause of the deposit, and try to prevent its formation. At the last meeting of this Association, the president, in his address, touched this subject, the result being a long correspondence in the JOURNAL OF GAS LIGHTING thereanent. Mr. Dunlop mentioned that if it were possible to work exhausters with a vacuum inside retorts, this deposition of carbon, and also choked pipes, would be things of the past. I have no doubt this would prevent the mischief; but, practically, as Mr. Dunlop says, it cannot be done. Mr. Paterson is of opinion that nearly the whole, if not the whole, of the said deposit is produced from, and out of, the tarry vapours, &c. Another correspondent of the JOURNAL is of opinion that a by no means inconsiderable portion of the carbon is produced at the expense of those richer constituents of the gas which remain under ordinary conditions permanent, hence the increased yield and higher illuminating power when an exhauster is employed. Again, Mr. Joseph Tysoe is of opinion that the cause is owing to the dialysis of gases, and that the hydrogen passes through the retort by virtue of the peculiar property it possesses, and that the carbon not possessing this property remains behind to form the incrustation.

In answer to the theory of dialysis, Mr. William Young shows that before the hydrogen can come into possession of this high diffusibility, it must be in the form of the simple element, not in combination. Again, Mr. C. Taylor says that he has seen cases where carbon has formed almost as rapidly in cast iron as in clay retorts, and if its presence is to be explained by dialysis, we must assume that action takes place through cast iron, combined with a considerable thickness of the deposit itself. Mr. George Anderson says, that with an exhauster you will have less carbon than without one—*ergo*, it ameliorates. But because I do not believe that pressure is the primary cause of the production of carbon, so neither do I believe that exhaustion can be a remedy for its entire removal. My experience has led me to conclude that it is high heat that is the primary cause of both carbon in retorts and stoppages in pipes. By removing the working pressure you ameliorate the carbon-in-the-retort disease; by low heats you effectually cure the stopped-pipe disease.

These are the opinions of engineers and managers of large works, as to the cause of this deposit, and exhausters are recommended to prevent, or lessen, the production of carbon. But as I have not had any experience of exhausters, and as this Association is composed of managers of small works, a good many of whom are in works where it would not be profitable to employ exhausters, I shall confine my remarks to other means of reducing the pressure on retorts. During the last three years numerous patents have been obtained for this purpose. We have the patents of Caffall, Thomas, and Co., Limited; Box's patent anti-dip valve; Hawkins's patent self-acting dip-pipes; Chandler's patent dip-pipe; Copp's patent anti-dip gas apparatus; Chandler and Stevenson's self-acting removable dip-pipe. Mr. William Key has also an arrangement for this purpose, and Mr. Boyd and several others. It is very remarkable that every one of these patents claims the same advantages—namely, the prevention of the deposit of carbon, and also the prevention of stopped ascension-pipes. But cannot these advantages be obtained without unsealing the dip-pipes in the hydraulic main? I will explain how it can be done, and in a way that will not disturb any of your apparatus, nor your present working arrangements. I fancied, like Mr. Dunlop, that I was nursing a child of my own; but, on reading over the discussion on Mr. William Key's apparatus, I find Mr. Bruce Peebles mentions Mr. Whimster as having a syphon from the bottom of his hydraulic main. Well, this makes me doubtful as to the paternity, and I fancy Mr. Whimster will be claiming this as his offspring; but that we shall see, perhaps, during the discussion on this paper.

My experience has led me to conclude that the actual and immediate cause of the deposit of carbon in retorts is mechanical pressure, and that the tar in the hydraulic main has a good deal to answer for, as causing this pressure. I am further of opinion that it is the tar in the hydraulic main which is the actual and immediate cause of choked ascension-pipes. Perhaps it will be as well here to state what has led me to form this opinion. Well, for some years I was employed as foreman in a large public work where we made our own gas, and part of my duties was to take charge of the manufacture, &c. We had two fire-clay retorts in one oven, and in about three months after putting them in new, they were generally about half filled with carbon. I tried several remedies; and, at last, put a stop-cock on the bottom of the hydraulic main, and ran off the tar. After cleaning out the hydraulic main, I filled it up with water, so as to seal the dip-pipes. Then, every time I charged the retorts I opened the stop-cock at the bottom of the hydraulic main, and allowed the tar to run off. Whenever ammoniacal liquor appeared, I shut the stop-cock, and the result was, that only ammoniacal liquor remained to seal the dips. There is no fear of running off too much to unseal the dips if you stop whenever the tar stops and ammoniacal liquor begins to come. The result of this simple arrangement was astonishing. From that day carbon has given me no trouble. A little gathers round the mouthpiece; but none on the back or on the top of the retorts. When I removed to my present situation three years ago, the works were new, and, at first, all went on well; but whenever the hydraulic main got filled with tar, choked ascension-pipes again annoyed me. I again applied the stop-cock to the bottom of the hydraulic main, and have never had a stopped pipe since. I may state that I placed a gauge on the H-pipe before the gas entered the hydraulic. The dips were 2¾ inches; with tar, the pressure was 10 inches; after running off tar and sealing with liquor, the pressure was 4 inches.

In conclusion, I advise any of those present to try this plan, and I will guarantee they will never regret it.

Mr. KEY: It is pleasant to those who take an interest in the Association to find young members coming forward with papers of this description, and I am pleased at the creditable appearance made by Mr. Smith and Mr. Martin. In regard to the latter gentleman, however, I think he has taken a roundabout road to arrive at his conclusion. To run off the tar at the bottom of the hydraulic main and leave the ammoniacal liquor is a good object, but that process can be avoided by the adoption of the system which I have fixed at several works, and which is self-acting. The tar is always heavier than water, and, consequently, falls to the bottom of the hydralic main. By my arrangement the tar rises up in the syphon, down the overflow-pipe, and so the tar always flows off first. That does not require any one to stand by and shut the cocks, for it is self-acting. Mr. Martin, however, has arrived at a correct conclusion when he says that the pressure is relieved by keeping in the water only—by running off the tar first and leaving only the ammoniacal liquor in the hydraulic main. But a system where this is self-acting is better than by the hand. I tender my thanks to Mr. Martin for bringing the subject under the notice of the Association.

Mr. YOUNG: Mr. Key has made an assertion which is only true to a certain extent, and that is, that tars are invariably heavier than ammoniacal liquor. It is strange fact that if you bring the tars above a certain temperature they become lighter than ammoniacal liquor—that is, that tars undergo a greater amount of expansion by an equal increment of heat than ammoniacal water. When tars get above a certain temperature they rise to the surface. At the same time I do not object to the practicability of the apparatus recommended by Mr. Key, because I believe where it is applied is principally in small works, and there the tars are below that temperature which will make them rise to the surface, but in large works, where the whole hydralic main is in action at once, I have my doubts that such will not be the case, and it will be found that the tar is uppermost, although in some cases it may be found otherwise. The German tar distillers, in separating ammoniacal waters from the tars, heat them until the tars rise to the surface, and then pump them off, or drain off the water from the bottom. Of course we cannot get inside the hydraulic main to see what is going on, but we can tap the side and see its contents at different levels, and I think it is worth while to make the experiment.

Mr. KEY: I have experimented, and I have found that there is water several inches above the tar. I have put ganges on different places and found on working that tar was always at the bottom, and in our works we always find tar at the bottom of the main.

Mr. YOUNG: Long before the tar comes up to the boiling-point of water, the water and tar approach each other in specific gravity; but if heated up to 180° you will find the tar beginning to come up to the surface, and I have no doubt that in many cases, such as in the Glasgow works, where the whole hydraulic main is in use, the tar is immediately in contact with the dip-pipes.

Mr. KEY: The paper demonstrates that in his working, Mr. Martin runs off the tar and then the ammoniacal liquor.

Mr. YOUNG: I quite believe that is the case in small works, but where the temperature in the hydraulic main is from 170° to 180°, the condition will be that the tar will rise, or so mix with the water as not to be removable by the device referred to.

Mr. KEY: I have never reached that yet.

Mr. YOUNG: That may be; but it is not more than a fortnight ago since I put the thermometer into a hydraulic main and found it 175°.

Mr. NIVEN: I can certify what Mr. Key has said. I was much troubled with heavy tars in the hydraulic, but now it is kept as clean as if there never had been tar there.

Mr. YOUNG: I am glad to hear that is the case. I am not at issue with Mr. Key so far as the mechanical arrangement is concerned; but I only wish to draw attention to the fact that tars expand more than water with an equal increment of heat, and that when a certain temperature is reached, the tars rise to the surface.

Mr. MONK: I beg to propose a vote of thanks to Messrs. Smith and Martin for their kindness in preparing and reading these interesting papers.

Mr. M'GILCHRIST: I beg to second the motion. I expected when I saw the title of this paper that there would have been a long discussion, and that some of the managers present would have given their experiences. In working retorts I find that a great deal depends upon the treatment they get when first put in. If I scrape them every day for the first fortnight or three weeks, I find, from some cause that I am unacquainted with, that the carbon does not afterwards grow nearly so quickly as it does when that is neglected. Mr. Young, who is a scientific gentleman who has long studied this subject, may explain the reason. I know other managers who have the same experience.

Mr. YOUNG: In one of my letters in the JOURNAL OF GAS LIGHTING I took notice of that. It is a fact that their roughened surfaces have the power of inducing decomposition of the products of distillation, which would not otherwise take place; and seeing that retorts are put in all rough and jagged, a deposition takes place which would in other circumstances not be there, and I think so all the more when Mr. M'Gilchrist says he could, by scraping for a certain period, prevent that deposition.

The motion for a vote of thanks to Messrs. Smith and Martin was then carried.

Mr. YOUNG (Clippens) read the following paper on

THE MANUFACTURE OF ILLUMINATING GAS.

In order to refresh your memory, and widen the discussion on the paper which I had the pleasure of laying before you at our Lanark meeting, some twelve months ago, I propose to-day to make a few remarks on the general manufacture of illuminating gas, either directly or indirectly bearing on the process referred to in that paper.

The manufacture of illuminating gas from coal may be conveniently divided into three separate operations—viz.: A. The destructive distillation, or what is technically known as carbonization of the coal. B. The chemico-mechanical operation of separating the condensable objectionable liquid and solid compounds, styled condensation. C. The purely chemical operations for separating the objectionable vaporous and gaseous compounds from the illuminating gas, and known as scrubbing and purifying. No doubt all three operations are more or less dependent on each other, and consequently require to be more or less treated of as one process; but as it is more particularly to the chemico-mechanical operation of condensation to which I desire to draw your attention to-day, I will only refer to the other operations (of carbonization and purification) in so far as they affect, or are affected by, the process of condensation.

The object generally aimed at in carbonizing a coal is so to conduct the operation as to produce the maximum volume of gas capable of giving the greatest gross amount of light—*i.e.*, neither to under nor over carbonize the coal; for if we do not subject the coal to a sufficiently high heat, the constituents of the coal are not sufficiently decomposed, and consequently there is a larger quantity of liquid hydrocarbon products formed—products which are capable of being diffused through a permanent gas, and giving thereto a high illuminating power; but in consequence of the under-decomposition of the coal, the gaseous products are small in volume, and even when saturated are able to absorb only a comparatively small quantity of the total liquid hydrocarbons. The small volume of gas has, no doubt, a very high illuminating power, in consequence of containing or being saturated with those vapours; but the gross illuminating power, or what is known as sperm value, is small.

On the other hand, when an excessive temperature is employed to carbonize or distil the coal, those liquid hydrocarbons and gaseous compounds, giving when burned a high illuminating power, are more or less decomposed and converted into denser hydrocarbons, solid carbon or soot, and marsh gas, or similar carburet of hydrogen, giving when consumed a low illuminating power; and further, even when a portion of the valuable hydrocarbons escape decomposition, the denser hydrocarbons produced from the portion which has been decomposed, absorb and remove them from the gases, unless certain precautions are taken during the process of condensation, for you will remember the experiment I made at our Lanark meeting, showing you how gases had the quality of holding diffused through them the vapour of the volatile hydrocarbons; but that on bringing the gases containing those diffused vapours into contact with denser hydrocarbons and tars, those vapours were more or less dissolved out of the gases; or, in other words, that the solvent action of the tars overcame the diffusive action of the gases, and absorbed hydrocarbon vapours from them till the diffusive action of the gases balanced the solvent action of the tars. You will also remember that it was shown, that in order to prevent this affinity of the tars for hydrocarbon vapours, it was only necessary to keep the tars, whilst in contact with the gases, in a heated state, as by our present mode of condensation such precautions are not taken.

It is evident that when coal alone is employed for the production of illuminating gas, the proper carbonization consists in just producing such an amount of decomposition of the elements of which the coal is composed, as is sufficient to convert the hydrocarbonaceous portion into the proper relative proportions of gaseous and liquid products; the gases being just sufficient to take up and suspend the hydrocarbons not absorbable by the tars, and the hydrocarbons being in sufficient quantity to carburet the gas against the absorbent action of the tars, for, as shown, by over-distilling the coal there is decomposed more of the volatile hydrocarbons than is desirable in poor gas, the volume being more than sufficient to take up any undecomposed volatile hydrocarbons left, suitable to carburet the gas; and again, when under-decomposed, the volatile hydrocarbons are produced in larger quantity than can be taken up by the smaller volume of gas simultaneously produced. The nearer, therefore, we can strike the balance between the desired production of the gaseous and volatile hydrocarbons, the nearer we approach perfection in the carbonization of coal pure and simple. But we all know that the practical accomplishment of that desired object cannot be attained under our present mode of manufacture; for, on charging a retort with coal, the amount of decomposition is never sufficiently great, because the cold material cools the retort below the proper temperature, and, therefore, during the earlier stages of the carbonization, the liquid hydrocarbons are always much greater than can be taken up and diffused through the simultaneously produced gas. On the other hand, during the latter stages of the carbonization, the elements in the coal are over-decomposed by passing through the heated coke surrounding the small lumps of coal, and far more gas is produced than is desired. All that we can, therefore, do with our present apparatus, is to subject the coal to such a temperature as shall produce the best *average* results during the whole period of distillation.

There have been, and are still being made, attempts to modify the operation of carbonization, with the view of remedying this defect of the process. The essential features of these modifications may be divided into two distinct classes. To the first class belong the many forms of arrangement for subjecting the tarry hydrocarbon vapours to a second carbonization or destructive distillation, either whilst combined with the crude gases, or after being separated from the gases by condensation. The second class of modifications consists in employing a gas, having a comparatively small or no illuminating power, as a medium for suspending the surplus volatile hydrocarbon vapours produced when bituminous coals are distilled for gas. To this latter class belong the various forms of what is known as the hydrocarbon process, and also the plan in many cases adopted of mixing and subjecting to carbonization two coals—one giving a very poor gas, the other a rich gas and an abundance of hydrocarbon vapours; the poor gas in this case serving to suspend or absorb those hydrocarbon vapours, and retain them in a permanently gaseous state at all ordinary temperatures.

If a gallon of crude coal tar naphtha is subjected to destructive distillation at a suitable temperature, there will be produced from 50 to 90 cubic feet of gas, having an illuminating power, when consumed at the rate of 5 cubic feet per hour, ranging from 16 to 30 candles, the quantity and quality of the gas being dependent upon the original constitution of the crude naphtha, and the temperature at which it is decomposed; but the maximum quantity, having an illuminating power of 25 candles, would not likely be more than 70 cubic feet; this equals in value 6 lbs. of sperm.

If the same quantity of crude naphtha was diffused through 10,000 cubic feet of a poor gas—say 12-candle gas—it would increase its illuminating power by from 2 to 6 candles, dependent on the per centage of carbon in the naphtha. Here, even taking the minimum increase, we have a sperm value of 68·5 lbs., or fully ten times that got by decomposition and conversion into gas.

Again, should the same quantity of naphtha be diffused through hydrogen and carbonic oxide (gases produced by the decomposition of water by means of heated coke or carbon), there would be produced from 500 to 1000 cubic feet of gas, 5 cubic feet of which would give a light equal to from 15 to 20 candles. Here again, even taking the smallest quantity, we have a sperm value of 25¾ lbs., or fully four times that got by decomposition.

Those results point conclusively to the fact that the first class of operations, whereby the surplus hydrocarbons are decomposed to form gas, is very wasteful. Especially is this the case when they are decomposed whilst diffused through the gases, because in decomposing the surplus hydrocarbon vapours, there are also simultaneously decomposed rich gaseous compounds, such as olefiant gas, which it is desirable to preserve. There is also another serious defect in this class of operations, which in itself is sufficient to prevent its adoption—viz, that in producing the decomposition of the hydrocarbons, we convert them into gases, denser hydrocarbons, such as naphthaline, &c., and finely-divided carbon or soot. A considerable portion of this sooty matter floats forward in the current of gases, and as there is not sufficient oily tar left to dissolve and wash it away, it soon collects in such quantities as to choke up the stand-pipes, hydraulic mains, and other parts of the gas apparatus.

So far, then, as our present knowledge goes, the best modes of utilizing coal for the manufacture of illuminating gas are those by which the maximum volume of illuminating gas and hydrocarbon vapours, suitable to carburet a poor gas, are produced direct from the bituminous coal, employing a poor gas to suspend those vapours and carry them to the consumer; for, by so doing, the maximum amount of illuminating power is obtained from the hydrocarbon vapours, the total quantity of the carbon of their constitution being thus retained and consumed; whereas, when they are decomposed, to convert them into gaseous compounds, a considerable portion of the carbon of their constitution is converted into denser hydrocarbons, insuspendible in the gas, and solid carbon or soot, and is thereby lost.

The means hitherto employed to carry out this diffusive mode of manufacturing illuminating gas consists, as already stated, in mixing a coal or other bituminous substance giving a very rich gas, and yielding a considerable quantity of hydrocarbon vapours, with a poor coal or other material giving a poor gas, and subjecting the whole to destructive distillation. If you will kindly give your attention to the diagram-table I. on the wall, you will see the results got by Dr. Macadam in his experiments made with mixed cannels, as also a few instances of results got by the late Mr. Cusiter, with mixtures of oil and splint coal.

You will observe that the gain in illuminating power ranges from 5·68 per cent. to 11·25 per cent, averaging 7·57, or 1-13th of the whole light given by the coal, in the case of the mixed cannels; but this gain is much greater when a mixture of coals or other bituminous substances, giving a very rich gas and abundance of hydrocarbons, is distilled with a substance giving a very poor gas, as indicated by the results got by the mixtures of oil and coal.

If, instead of employing a poor coal to produce the gas necessary to suspend the hydrocarbon vapours produced simultaneously from a rich coal, hydrogen and carbonic oxide, obtained by the decomposition of water by highly-heated carbon, be used (constituting what is known as the hydrocarbon process), the per centage gain is sometimes astonishing. The diagram-tables II. and III. give the per centage gain in the experiments made by Dr. Frankland upwards of twenty years ago, as also other results of experiments made by the Gwynne-Harris process in America, by Professors Würtz and Silliman, and published in the JOURNAL OF GAS LIGHTING.

The principal obstacle experienced in carrying out the mode of mixing the coal during carbonization is the quality of the resulting coke. In very many cases, our richest coals and shales give a coke containing so much ash as to render them almost valueless, and when mixed with a coal giving a good coke, deteriorate its value to such an extent that gas managers find it to their advantage in many cases to distil the various coals and shales separately, as even the 10 or 12 per cent. gain in illuminating power does not cover the inferiority of the resulting coke.

Hitherto the hydrocarbon process has not been extensively adopted, the objection to its employment being principally the want of uniformity in the illuminating power of the gas manufactured. At one time the gas would be all that could be desired, and, at another, so poor as to be fit only for heating purposes. This want of uniformity arises from the difficulty experienced in regulating the supply of water gas necessary to take up and suspend the volatile hydrocarbons produced along with the rich gases from the coal undergoing carbonization. By any of the forms of apparatus hitherto employed, it is essential that the water gas should be passed into the retort whilst the bituminous coal is undergoing distillation, and in as near as possible the proportions necessary to combine at once with the hot hydrocarbon vapours as they are produced from the coal, because should the water gas be more than sufficient, the resulting mixed gases are deteriorated in their illuminating power by being diluted to excess. On the other hand, should the water gas be insufficient to take up the whole of the hydrocarbon vapours, the surplus will be condensed and removed amongst the tars and lost; and as, during the distillation of a charge of coal, the quantity of hydrocarbon vapours produced suitable for being taken up by the water gas is constantly altering—being most abundant during the earlier stages of the distillation, and gradually diminishing till, during the latter stages, they are entirely wanting—it can easily be conceived that there would be considerable difficulty in regulating the requisite supply of water gas, and that although it might, in the hands of an experienced chemist, be a very successful process, yet it would be practically valueless.

From the foregoing description of the modes of carbonizing coal for the manufacture of illuminating gas, it will be evident to you that were it possible by any convenient means to take the surplus hydrocarbons from the earlier stages of the carbonization of coal, and diffuse them, or a considerable portion of them, through the poor gas produced during the latter stages of the distillation, or to diffuse the surplus hydrocarbons derived from the separate distillation of a rich coal or shale through the gas derived from the separate distillation of a poor coal; or if it were possible to make the quantity of water gas employed in the hydrocarbon process a *fixed* quantity, independent of any stage of the distillation, many of the defects in the diffusive process of gas manufacture would to a considerable extent be overcome. This it is proposed to accomplish by employing the analyzing, or fractional, condensing apparatus which was described at Lanark.

Before proceeding to describe how this desirable object may be accomplished, and the apparatus applied for that purpose, it is necessary that I should make a few remarks on the present modes of treating the crude gases during condensation and purification.

As already stated, when coal is carbonized or destructively distilled for the manufacture of illuminating gas, the elements of which it is composed are broken up and re-arranged to form a great variety of compounds, the relative quantities of which are dependent upon the nature of the coal and the temperature at which it is distilled. But at whatever temperature it may have been distilled, and whatever may have been the character of the coal, the products of its distillation as delivered into the hydraulic main are composed more or less of the constituents named in the tabular diagram, to which I ask your attention for a few moments.

You will observe that the table is so arranged that in the left-hand column are first given the names and rational formulæ of all the gaseous compounds that it is desirable to leave in the purified gas. Next in order come the neutral hydrocarbon compounds which it is desirable to retain as much as possible suspended or diffused through the gas, as they very much add to its illuminating power. Then come water, and the acid and alkaline bodies, followed by the solid carbon, or soot; and, lastly, we have the main gaseous and vaporous impurities ordinarily left in the gas as it leaves the condensers, and which are, as far as possible, to be removed by purification.

Now, it very much depends upon the manner in which we treat this complex distillate, what is the nature of the resulting illuminating gases and other products. We know what we want; but it is questionable if we at present know the proper means to accomplish our aim. If, for instance, our present modes of treating those various products were perfect, the whole of the valuable gaseous products, and as much of the vapours of the neutral hydrocarbons as could be suspended or diffused through them at ordinary temperatures, would be sent to the gasholder for sale, and that those hydrocarbons that were used for carburetting the gas would be those most volatile, and, therefore, best adapted for the purpose; but that such is not the case, I have only to remind you of the enormous quantity of benzole annually distilled from the tars, and sold as such, and of the complaint made, when common coal is used, of the stoppage of the pipes with solid naphthaline deposited from the gas.

If you will now refer to the diagram-table IV., you will see the main constituents of coal tar and their products as they are given in "Chemistry as applied to the Arts and Manufactures" (article, "Coal Tar Distillation"), at present being published. You will observe the list gives not only the names of the volatile neutral hydrocarbons which should have been left in the gases, but even the hydrocarbon gases themselves dissolved through the tars. Now, why is this the case? Why are we leaving in our tars hydrocarbons and gases which should have been sent into our gasholders and sold, and, on the other hand, putting into our gases naphthaline and other hydrocarbons far less suited for the purpose, and which should have been left in our tars? Simply, in my opinion, because we have hitherto been endeavouring to do more with our condensers than was desirable. We have been making the tars, ammoniacal water, and gases to travel and cool together, with the object of strengthening the ammoniacal liquor, and allowing the tars to take up bisulphide of carbon and other sulpho-compounds, overlooking the fact that the tars have quite as strong an affinity for the neutral hydrocarbons as they have for the objectionable compounds we wish to remove; and that, in producing the conditions essential for the action of the tars and water on the impurities, we were producing the very best conditions possible to supply the tar distiller with benzole.

To understand how gas should be condensed, the tars proper removed, and the hydrocarbons left in the gas, we cannot do better than take a lesson from the tar distiller, who, when he desires to separate the naphthas from the tars, employs what is known as the "Coffey" still, consisting of a vertical

chamber, into which are placed a large number of trays or shelves. Into the top of this chamber he pumps the tars, which run down from shelf to shelf, at the same time introducing an atmosphere of steam at the bottom, which, meeting the current of tars, heats them, and absorbs from them the vapours of the naphthas; the mixed vapours and steam being drawn off at the top and condensed; while the tars, denuded of the naphthas, flow from the bottom. On very similar principles should the process of condensation be conducted, only as the tar distiller gets his tars condensed, and in the liquid form, whereas we get ours in the crude gases, first as vapour and finely-divided carbon or soot, or in the form of suspended tarry particles floating through the gas, the general arrangement of the "Coffey" still has to be so modified that those solid and liquid matters may be allowed to settle out, and the atmosphere of the crude gases themselves employed to suspend the vapours of the volatile hydrocarbons till removed from the sphere of the absorbent action of the tars proper, the gases being then allowed to cool and deposit the surplus vapours, to be afterwards employed to carburet poor gases, or those not already saturated with vapours.

To attain these conditions, it is essential that the gases be allowed to travel slowly, and that the tars be kept in a heated condition as long as they are in contact with the gases. The shelves in the analyzer, or "Coffey" still, must be set wider apart than is usually the case, and the shelves or trays made double to admit of steam being employed to keep the tars hot. As most of you are already aware, such is the form of apparatus which it is proposed to employ to overcome the defect of what I may be allowed to style the diffusive mode of making illuminating gas from coal.

I have here a sectional model of such an apparatus, which is similar in construction to that shown by a sectional drawing at our Lanark meeting,* and identical in form to that recently erected at the Corporation Gas-Works, Hamilton, and exactly 1-12th the size. As some of the members present to-day may not have been present at the Lanark meeting, I will briefly recapitulate the description of the working of this arrangement given at that meeting. This analyzing arrangement consists, as you see, of a vertical tower or chamber, having tray diaphragms placed at intervals, and arranged in such a manner that the gases, in passing between those trays, are caused to travel in a tortuous course alternately from the centre to the sides, the apertures through which the gases have to pass being alternately at the sides and the centre of the trays. The trays are so formed as to hold a few inches in depth of tar or liquid hydrocarbons. Hanging from the edges of the central apertures of the trays, and dipping into the tars or hydrocarbons contained in the trays underneath, are tubes of wire gauze. Two of the lower trays, and the bottom of the lower compartment, are, as you see, double, and into the space steam is admitted to keep the tars heated.

The crude gases, suspended finely-divided liquid tars, and water enter by this pipe at the bottom, and pass over the tars, which are kept hot by the steam in the manner just described. The heated tars give off any volatile hydrocarbons they contain, which, on diffusing through the gas, come into contact with the mechanically finely-divided tarry particles suspended in the crude gases, and being absorbed by them, add to their weight, and tend to make them coalesce and settle out, or separate as they pass through the first wire netting hanging from the lips of the second tray. The tars as they settle out or run back into the trays or jacketed bottom become heated, and again part with the absorbed volatile hydrocarbons to carry down a further quantity of tarry particles, or, if not needed, or in greater quantity than required, they pass on with the gas. This process is just repeated at each of the other two jacketed trays, the volatile hydrocarbons being alternately volatilized by the heat of the steam and the diffusive action of the gases, and the tar particles are, so to speak, washed out with the hydrocarbon vapours. The crude gases are then further fractionally condensed as they gradually ascend from compartment to compartment, depositing the denser hydrocarbon vapours, and retaining or absorbing more of the lighter ones flowing from each successive tray, till, on reaching the outlet-pipe leading to the scrubbers, they contain a very small quantity of tars proper, but are saturated, or contain as much of the hydrocarbon vapours suitable for carburetting the gas as they can hold in diffusion at ordinary temperatures, or as much as may have been present in the trays.

A short time after making the communication at Lanark, and whilst making further experiments with this arrangement, we discovered that, however perfectly a gas was charged with the hydrocarbons produced along with it from a given coal, yet there were always more or less hydrocarbon vapours left in the upper trays of the arrangement, which, when a poor gas from another coal was brought into contact with them, were taken up and diffused through it—*i.e.*, it was found that, on treating the gases produced from any of the rich cannels or shales, by passing them through such an arrangement as this, then passing the gas produced from a poor coal, giving, say, 14-candle gas, through the arrangement containing the residual tars and hydrocarbons, there would be produced, not, say 15 or 16 candle gas (which might be expected from the more complete diffusion of the hydrocarbons produced from the poor coal itself), but gas having an illuminating power of from 23 to 25 candles. Those results naturally suggested the use of water gas (hydrogen and carbonic oxide) to absorb and suspend the surplus hydrocarbons left in the arrangement when a rich coal was distilled. Experiment proved the practical suggestion to be correct, for, on making trial of water gas, there was obtained a large increase of volume and a considerable gain in the gross sperm value.

It will be evident to your practical minds that there are considerable advantages in being able thus to utilize the hydrocarbons from a rich coal. You will observe that the surplus hydrocarbons from the earlier stages of the distillation of a charge of coal are not lost by being condensed and removed amongst the tars (as is the case where ordinary modes of condensing are employed), but that they are volatilized by the heat in the lower trays, and left behind in the upper and cooler trays of the arrangement till taken up by the poor gas produced during the latter stages of the distillation; and that, in a similar way, a poor and a rich coal may be distilled separately, yet advantage taken of the surplus hydrocarbons from the rich coal to carburet the poor gas; and that, when the hydrocarbon process is worked, it is not essential that the water gases and bituminous gases be made at the same time, but that the bituminous gas may be made first, the surplus hydrocarbons fractionally condensed out and left in the upper trays of the arrangement, and the water gas afterwards made and employed to absorb and take up those vapours, and form illuminating gas.

I dare say most of you, on looking into a retort, on the lid being removed to discharge, will have observed the beautiful coraline deposit of carbon hanging from the roof of the retort and formed on the external surface of the cokes even of coals and shales, whose cokes are worthless as fuel. We are all also disagreeably aware of the constantly accumulating deposit of carbon on the inner surface of our retorts, both forms of deposit being, as you are aware, produced by the decomposition of the volatile products of the coal. The former deposit of carbon is at present lost, for it is so friable that during the drawing of the charge it is crushed to powder; and the latter deposit is a source of considerable annoyance and loss. Now one of the advantages of this new diffusive mode of conducting the hydrocarbon process is that, instead of those deposits of carbon being a source of loss and annoyance, they may be made the source of considerable gain, for of all forms of carbon suited to the decomposition of steam into carbonic oxide and hydrogen, this finely-divided deposited carbon is the best. Thus we are enabled to first charge our retorts with coal, distil out the volatile carbonaceous portion as gas and hydrocarbon vapour, that those in an arrangement such as that before us, by which the surplus hydrocarbons are retained, and on the distillation being completed, or nearly so, by introducing steam, we employ the deposited carbon to decompose it into carbonic oxide and hydrogen, to take up those surplus hydrocarbons left in the arrangement, and with them form illuminating gas. In the same way, many of our shales giving abundance of hydrocarbon vapours and rich gases, but having a coke worthless as fuel, may be economically used, for a portion of their carbon may be used to assist in the decomposition of steam, and form water-gas to take up the abundance of hydrocarbons produced, when they are carbonized.

But although it is not essential that the bituminous gases and water gases be made at the same time, yet, when this can be conveniently done, it is better the water gas be passed into the retort containing the bituminous coal or shale, and there mingled with the crude bituminous gases as they are eliminated, for it appears from the results of experiments that the poor gases serve to shield from over-decomposition or in some other manner conduce to the formation of a greater quantity of the hydrocarbon vapours suitable to carburet the water gas. A simple way to accomplish this is to make the distillation of the bituminous and water gases alternately in two retorts, connected in such a manner that the gases may be passed alternately from the one to the other; or where through retorts are used, by making the bituminous gases in the one end and the water gases in the other, and causing the water gases always to travel over the bituminous matter on their way to the stand-pipe.

The quantities of water gas (hydrogen and carbonic oxide) required to take up and hold in diffusion the hydrocarbon vapours produced from any given coal or shale, and therewith form a gas of the desired illuminating power, must first be ascertained by trial, by distilling a weighed quantity of coal, and adding water gas in the manner proposed to be worked till the desired illuminating power is attained. The requisite quantity being ascertained, it is only necessary to note that there is registered by the station-meter the proper quantity for each ton of such coal carbonized. Thus, say that one ton of rich shale is used, giving 8000 cubic feet of 38-candle gas, and that the hydrocarbons produced simultaneously are able to carburet water gas to such an extent that before the whole bulk of the mixed gases is brought down to 28 candles (that being the illuminating power of the gas desired) they amount in volume to 14,000 feet. Then all that is necessary is to see that for every ton of such shale carbonized there is registered by the station-meter 14,000 cubic feet, for whether the bituminous and water gases be made alternately or simultaneously in separate retorts, the action of the analyzing arrangement is such that the gases are carburetted, for should the water gases not be in sufficient quantity to take up the whole of the hydrocarbon vapours simultaneously produced, the surplus is deposited in the upper trays of the analyzer; and, on the other hand, when the water gases are more than sufficient to take up the hydrocarbons from the bituminous gases, then the previously condensed surplus hydrocarbons contained in the trays serve to supply the deficiency.

Such is the general *rationale* of the simplest means of conducting this method of gas manufacture; but there are many modifications of it to suit the varying circumstances of gas-works, the nature of the bituminous material employed, &c., to take notice of which would extend this paper to far too great a length. I must, therefore, refer you for further information on the subject to the specification of patent dated Aug. 3, 1875 (No. 2725).

As the means employed in conducting this process, for the utilization of the volatile hydrocarbons, are such as to prevent the direct action of the tars and water on the ammonia and other impurities in the crude gases, it is evident that the crude gases must pass from this new analyzing arrangement containing far more ammonia, sulphuretted hydrogen, carbonic oxide, sulpho-hydrocarbon compounds, &c., than when the ordinary condensers are employed. At first sight, this might appear a very great objection; but if we give a little consideration to the matter, we shall see that such is not the case, but that from various reasons, over and above those already referred to, the present modes of applying the water and tars during condensation to absorb the impurities from the gas are objectionable.

Now when the horizontal and other similar forms of condensers are employed, and the water and tar made to travel along the bottom of the pipes in contact with the gas, or suspended in fine particles through it, there is not the least doubt but that the thin film of tar, more or less covering the water, impedes its absorbent action; and further, there is this defect in this mode of applying water, that just in proportion as the water takes up the ammonia from the gas, its power to absorb more is diminished; because not only is the affinity of the water for the ammonia lessened, but the relative diffusive action of the gas is increased till it is such as to hold in diffusion what ammonia remains combined with it.

It is quite evident that by causing a limited quantity of water to travel in the same direction as the gas, it is impossible to deprive it of all its ammonia, for, however weak the solution of ammonia may be, there is always left diffused through the gas a quantity, more or less, dependent on the strength of the ammoniacal solution formed. But if, on the other hand, we reverse the manner of applying the water, by causing it to travel against the current of gases, it is evident that, as the water enters where the gases are passing, it is almost deprived of its ammonia by the water it has met in its course. The strong diffusive action of the gases for the remaining traces of ammonia will be overcome by the equally strong solvent action of the pure water, and as the water travels against the current of gases, this balance of affinity is continued, for gradually as the water absorbs ammonia, and loses a part of its absorbent power by flowing against and meeting the current of crude gases, it is as constantly brought into contact with gases richer in ammonia, part of which it is able to absorb; and gradually as the gases, on the other hand, are deprived of the diffused ammonia, and their diffusive action, for what remains, relatively increased, they meet with water containing smaller and smaller quantities of ammonia in solution, and consequently have a stronger solvent action for what ammonia remains in the gases. So far, then, as the action of the water on the ammoniacal compounds alone is concerned, this process is not objectionable, for the water as it leaves the bottom of the analyzing arrangement may, to all intents and purposes, be said to be pure, only containing, as it does, traces of ammonia and small quantities of the acid and alkaline and denser hydrocarbons in solution, which do not appreciably affect its action on the ammoniacal compounds in the crude gas; and, therefore, by cooling this water, and employing it in the manner indicated, by causing it to travel against the current of gases, as is done in the ordinary scrubbers, or by employing it in an arrangement similar in its action to that recently given and described in the JOURNAL OF GAS LIGHTING, by Mr. George Anderson, of London, it will be evident to you that the same quantity of water might be made to take up a much larger quantity of ammonia, because the gases, when brought into contact with the already strong ammoniacal liquor, contain all the ammonia produced with them, and, therefore, capable of adding to the strength of the solution. This is of considerable advantage where the solution of the ammoniacal compounds has to be carried to a considerable distance to have the ammonia extracted.

There is also another objection to the present mode of applying the water to absorb the ammoniacal compounds from the gas, to which I do not think sufficient attention has been given. I dare say most of us are more or less conversant with Mr. Hills's new process of purification, by the employment of the ammoniacal liquor to remove the sulphuretted hydrogen and carbonic acid from the gas. You are aware that in order to revive or render again partially caustic the ammonia, he by suitable means heats the crude ammoniacal liquor

* See JOURNAL, vol. XXV, page 805.

which has the wonderful effect of causing it to part with the greater portion of the sulphuretted hydrogen and carbonic acid gases held in solution by the water, and combined with the ammonia, the solvent action of the water for the ammoniacal gas being apparently so great that, at the particular temperature employed, the ammoniacal salts are decomposed, the gaseous acids liberated, and the ammonia held in solution by the water.

Now by our present method of allowing the water to absorb the ammonia whilst in a hot state, we are just doing what Mr. Hill does. We are allowing the water to absorb and hold on by the ammonia, in a more or less caustic state, and preventing it from combining with the acid gaseous impurities in the crude gas; hence the reason we have to pump our ammoniacal liquor over and over again through a scrubber or washer before we get it to absorb all the gases it can combine with. By this new method we do the reverse of this. We keep the water so warm that it is prevented, or nearly so, from directly absorbing ammonia, except as sulphocyanide, and the ammoniacal gas and acid gaseous impurities are allowed to travel forward, with only sufficient water to prevent the decomposition, in the crystalline state, of the ammoniacal salts formed; and when the cooled water is again presented to the gas, the ammonia is ready to be removed in a combined state as carbonate, bi-carbonate, sulphide, sulphocyanide, and other salts of ammonia, and as the gases during their transit in the analyzer are almost completely deprived of every trace of tarry matter, the absorbent action of the water is in no way impeded, but the gases may be by one single operation completely denuded of the ammonia, perfectly saturated or combined with gaseous impurities, and a much stronger solution formed than by the old method.

We all know that during the summer months we are able to purify far more gas, with a given quantity of lime, than we are able to accomplish during the winter. No doubt this is, to a great extent, in consequence of the slowness of the current of crude gas passing through the lime during the summer, as compared with the winter months; but I also believe that the more perfect condensation and precipitation of the tarry impurities which take place in warm weather have also a considerable effect upon the quantity of lime required, because the particles of lime are left free to exert their full chemical effect, not being clogged with the tar. Now, as already stated, as the process removes from the crude gases nearly every trace of tar proper, and enables the ammonia to combine with and remove an extra quantity of gaseous impurities (carbonic acid and sulphuretted hydrogen), the effect must be a reduction in the quantity of lime or other purifying material required to purify a given quantity of gas.

I have already shown how objectionable it is to allow the cold tars to absorb the bisulphide of carbon; because, by so doing, we very much deteriorate the illuminating power of the gas, as the tars also dissolve the valuable illuminants; but there is no such objection to the process for the removal of the bisulphide by the sulphide of the alkalies (lime), as recommended by Mr. Patterson, of London. It is obvious, therefore, that this is the proper means for its removal. The sulphide of lime costs nothing, being formed by the removal of the sulphuretted hydrogen from the gas.

Before concluding this paper, and whilst on the subject of gas purification, I am desirous, and trust you will kindly allow me to make a few remarks on the objections to the purification of gas by hydrated peroxide of iron. The subject has not a direct bearing on this process, but, indirectly, it is connected; and I am further induced to make the few remarks I have to lay before you in consequence of the very kind manner in which the Editor of the JOURNAL OF GAS LIGHTING referred to our annual report of the statistics of the gas manufacture of Scotland. I dare say most of you will remember that he drew particular attention to the fact that lime was, with rare exceptions, the only purifying material used in Scotch gas-works, and at the same time expressed a hope that something would be said on the subject at this meeting.

Some eleven or twelve years ago, I first made trial of oxide of iron for purifying a very rich gas made, at Lasswade Gas-Works, from shale. I had not used it long before I discovered a very marked reduction in the illuminating power of the gas. Not being quite sure whether the purification by oxide was the true cause, I again tried the lime, when the illuminating power came all right; and on again employing the oxide, the gas, as before, lost in illuminating power, so much so that I was ultimately compelled to abandon the use of oxide altogether. As at that time I had neither the opportunity nor yet the apparatus at my disposal to investigate the subject, I brought it before the members of the North British Association, at one of their meetings, gave them my experience, and asked for information on the subject, when, if my memory serves me right, various members mentioned having experienced a similar reduction in the illuminating power of their gas on using oxide of iron for purifying, but no definite explanation was given as to the cause.

It was only on reading the remarks referred to in the JOURNAL OF GAS LIGHTING that I again began to think on the subject; and I have since made several experiments, which, in my opinion, throw a ray of light on the cause of the reduction of the illuminating power of gas when hydrated oxide of iron is used and which has induced Scotch gas managers, who, as a rule make a rich gas, to abandon its use.

You are all aware that the hydrated oxide of iron may be and is used over and over again, the sulphur, with which it combines and removes from the gas, being exchanged for oxygen when exposed to the atmosphere. This Table illustrates the chemical changes which occur during the action of the hydrated oxide of iron when employed to absorb sulphuretted hydrogen, and its subsequent revivification:—

Absorption of Sulphuretted Hydrogen by Hydrated Oxide of Iron.

Fe_2HO_6	+	$6\,SH_2$	=	Fe_2HS_6	+	$6\,OH_2$
Hydrate of Iron.		Sulphuretted Hydrogen.		Hydrosulphate of Iron.		Water.

Revivification

Fe_2HS_6	+	$3\,O_2$	=	Fe_2HO_6	+	$3\,S_2$
Hydrosulphate of Iron.		Oxygen.		Hydrate of Iron.		Sulphur.

The only limit to the continued application of the same hydrated oxide being that the liberated sulphur ultimately accumulates to such an extent that it clogs or otherwise impedes the action of the oxide. Before this is the case, the sulphur amounts in many cases to from 40 to 50 per cent., and therefore when a ton of oxide is charged into the purifier, there is also charged along with it about half its weight of sulphur. Now, on my attention being directed to the subject, it occurred to me that as coal tar naphtha was a solvent for sulphur, this sulphur might be a solvent for the naphtha vapours held in diffusion through the gases, just as naphtha is a solvent for rubber, and, as we all know, rubber is a solvent for naphtha, and that rubber tubing, if of a great length, affects the illuminating power of the gas that passes through it. The first spare time I had I called on my friend Mr. Key, at the Tradeston Gas-Works, and got from him samples of his fresh and saturated, or spent, oxide. Through those I passed, in a suitable arrangement, a gas made by carburetting hydrogen with naphtha vapours. The fresh oxide had no appreciable effect as soon as its pores became mechanically filled with the gas; but the spent oxide, or that containing the deposited sulphur, &c., continued to remove or dissolve out of the gas upwards of 40 per cent. of the diffused vapours of the naphtha. On subjecting gas made from Lesmahagow cannel in a similar manner, it was reduced in illuminating power nearly 15 per cent. Of course, this absorbent action of the sulphur is limited, and would continue for a limited period only; but from some rough experiments I have made by passing gas highly charged with naphtha vapours through spent oxide in a tube, I am led to infer, as at present employed, it might form a rich gas, taking up at least one-half per cent. of its weight of liquid hydrocarbons. If the action of the separated sulphur is such as that indicated (and I have not the smallest doubt but that it is so), we can easily understand how the illuminating power is reduced, for each time the oxide containing sulphur is charged it will take up a considerable quantity of rich naphthas from the gas, and on being taken out to revivify, the absorbed hydrocarbons will be liberated by the combined action of the heat and by the diffusive action of the air, and the sulphur again left free to act on the illuminants in the gas when charged into the purifiers.

There is also another cause which has suggested itself to me. Hitherto we have been in the practice of using the oxide first to absorb out sulphuretted hydrogen, and lime afterwards to take out the carbonic acid; and as, by our present modes of condensing, there is always more or less tar carried forward on to the first tray of the purifiers, the oxide, on being revivified, gives off the very volatile portion of this tar, but the denser portions are left behind, and those, on being returned to the purifier, re-absorb a fresh quantity of hydrocarbons from the gases.

And now, gentlemen, I have done. No doubt many will be saying it is full time I should be, and I assure you I can heartily join with such, for I had no intention, when I first took pen in hand, to write such a paper as this; but the subject grew upon me as I got along, till it became what it is; and even as it is it only takes notice of the subject in a very superficial manner, yet I hope in such a manner as to convey to your minds the general *rationale* of the effects of this new process of condensation.

[Want of time prevented the reading of the whole of this paper.]

Mr. KEY: The reading of Mr. Young's paper has been greatly curtailed; but he has given us the gist of the subject, and I can thoroughly see the object he has in view in making this arrangement under his patent. The creating of hydrogen by steam is an auxiliary to our ordinary working, and the fact appears to be quite patent that the hydrogen does take up a very large volume of the naphthas or hydrocarbon vapours; but it appears to me, by making a larger production of gas obtained by higher heats, and passing that gas over the tars, that that gas itself would take up the naphthas from the tars again, and hold them in suspension. I remember calling upon Mr. Walker, of Ayr, late of Kilmarnock, and I noticed he had a large hydraulic main, three feet square, over his benches. I have no doubt the object he had in view was to pick up the hydrocarbons in travelling over a heated surface. I think that must have added to his gases very much. I remember a few years ago having a tank, into which I ran the liquors from the hydraulic main, and I kept it up to the boiling point. I made a large volume of gas at the time—upwards of 13,000 cubic feet. When the liquors in the tank came up to the boiling point they would boil over, and that was dangerous, because of the fire. One day the tank boiled over, and I got a good scald. The object, however, is a correct one, and the application of steam is a nice idea, because you have steam more under control. I must say the whole thing is got up in a very natural and scientific manner; and, as to the results, I thoroughly concur with Mr. Young. The subject of working oxide of iron in the purifiers was brought forward by the Editor of the JOURNAL OF GAS LIGHTING. I only learned the other day of Mr. Young's experiments, and I at once made arrangements to put a small purifier on my own testing apparatus—a small biscuit-box some 10 inches square—and put 400 inches of oxide, containing 25 per cent. of sulphur, in it; but as yet I cannot actually say whether it is from a defect in my arrangements or not, but I cannot detect any change in the illuminating power, which is the same through the oxide as by the regular mode.

Mr. BLACK: I have used the oxide, and I do not think it affects the gas so much as Mr. Young supposes. After working with it for ten years, I find no difference in my gas. I have a run of pipes nearly two miles long, and for a considerable distance over rocks, where I cannot get them properly covered. During cold weather the gas is consequently affected, but when the good weather comes, I know no difference in the light. I have experimented considerably upon it, and for the greater part of a year I have driven fully 1½ million cubic feet of gas through 3 cwt. of lime and 8 cwt. of oxide, and I cannot find any difference. The great secret in managing oxide is not to allow it to get over heated. It is worth trying.

Mr. SKINNER: I wish to ask Mr. Young a question or two about the production of carbonic oxide and hydrogen from water. It occurs to me as very possible that you will produce along with those gases too much free oxygen, and seeing that the oxygen cannot be removed, I want to know if it deteriorates, or in any way takes from the illuminating power of the gas. I also want to know if Mr. Young has been able, or whether he knows at what temperature or temperatures gas can be condensed, or lose those hydrocarbons which it has taken up. Another thing which I think would result, and it is very important, is on the indication of meters. According to the laws of diffusion, gas having much hydrocarbon vapours will be heavier than ordinary gas, and, in my opinion, the indication would be much less, whereas with the common coal gas we should get a better indication—that is, as the gas gets heavier the indications will be less.

Mr. D. M. NELSON: Allow me to say a word, but not on the paper which has just been read. Like all Mr. Young's other papers, it has, no doubt, been well digested, and I am sure it was well prepared. One remark I would make is in reference to gas passing through india-rubber tubes. He tells us it loses luminosity when it does this. I have reason to believe the deterioration is very considerable in passing through a white india-rubber tube, and that it is inconsiderable when passing through a red or black rubber tube. This is a fact which should be universally known, for the reason that a good deal of luminosity is lost, especially in connexion with table-lamps, by using white rubber tubes.

Mr. BLACK corroborated what had fallen from Mr. Nelson, and gave an instance in point, showing the benefit that had resulted from the substitution of a red for a white tube.

Mr. YOUNG: In reference to Mr. Key's remarks, "Would it not be as well to use a high heat, and thereby produce a greater decomposition of coal, and consequently get an increased volume that way, instead of increasing it by other means?" I think I made the remark in this paper that by diffusing a gallon of naphtha vapour through 10,000 cubic feet of gas we would increase its luminosity equal to about 60 lbs. of sperm; but that if we convert an equal quantity of naphtha into gas by decomposition, we would get an illuminating power equal to 6 lbs., or only one-tenth of that got by diffusion. With reference to the case of water gas, I may state that it might not be advisable in all cases to use it. More especially is this the case in colliery districts, where we can get from ordinary coal slack some 7000 or 8000 cubic feet of gas, and by employing the naphtha vapours from the rich coal or shale to carburet the gas, we would raise the illuminating power of that gas from 4 to 8 per cent. for each grain of naphtha vapour so added, whereas by decomposing naphthas we would only get about one-tenth of this illuminating power. But the case would be very different away in the interior of Europe, or at any distance from the coal-fields. Take the town of Mexico referred to by the chairman. I remember reading somewhere in connexion with the manufacture of wood gas that coal there cost some £20 per ton. Now, it might not pay us to make water gas here, where we can get our coal slack at some 4s. per ton, but where we have to pay £20 per ton there is no doubt that water gas is the proper agent to employ, or a poor gas derived from some other material. This apparatus is not made for this country alone, although it is applicable to it. For instance, in our Highlands, where the carriage is very dear, a rich coal could be employed, and a poor gas made, either by the decomposition of steam, or from peat or other source to take

up the hydrocarbons derived from that tar. These hydrocarbons would otherwise be valueless from the amount of carriage to convey them to the market. The object of my drawing your attenttion to this arrangement is to show that the working of the process is such that we can store up our hydrocarbons and hold them until the poorer gas is brought into contact with them. By the ordinary method the hydrocarbon vapours are condensed along with the tars, which run at once into the tar-tank, and are consequently lost. In regard to Mr. Key's remarks on oxide of iron, perhaps the material that I used was slightly different from what he used; but I am satisfied that oxide has the power of absorbing the illuminating qualities from the gas, and I think, if Mr. Key will repeat the experiment more carefully, he will find there is a marked diminution in the illuminating power. More particularly will this be the case when the gas is very rich, and is nearly saturated with hydrocarbon vapours, and where the gases brought into contact with the oxide have not been properly condensed, and the tars consequently left behind to act in the way I have indicated. Then in regard to the remarks made by Mr. Black, he tells us that by using oxide of iron, and preventing it overheating and volatilizing the more volatile hydrocarbons, and leaving the denser ones behind, that it does not deteriorate the illuminating power of the gas. I am at one with him that were this possible such would be the case; but the great difficulty is to prevent the oxide of iron from heating. I never yet saw oxide of iron but it became heated during the process of revivification, and more particularly during the earlier stages of its working. However, I may say that it is not essential that the materials containing hydrocarbons should be heated to cause them to be diffused, because the diffusive action of the air is such that they would be removed; and, further, it is a fact that sulphur will take up the hydrocarbons if brought into contact with them suspended through the gas, especially when that gas is near the point of saturation, and in the oxide we have sufficient sulphur to affect, to a considerable extent, the illuminating power of our rich Scotch gases. It is sufficient for me to draw your attention to this fact, and, perhaps, the members will make further experiments, and give their opinions on future occasions. I may further state that the action of lime on the oxide during the process of purification is very different on the products of distillation, not only from the causes which I have indicated, but from others which I am not at present prepared to lay before this meeting, although I hope to do so at some future time. Mr. Black says he has passed 1,500,000 feet through 3 cwt. of lime. I believe that he may have passed this quantity of gas through lime, but that it did entirely remove the carbonic acid from the gas I am not prepared to admit. My opinion is that 3 cwt. of lime would not take up the carbonic acid from 1,500,000 cubic feet of gas, such as that made in a country work, and not subject it to the process of scrubbing. Consequently, if the carbonic acid was not completely removed, there would no doubt be deterioration in the illuminating power of the gas, independent of any other action which the oxide may have. Then Mr. Skinner makes allusion to the deterioration of the illuminating power, as I understand him, from the quantity of carbonic acid produced along with the hydrogen and carbonic oxide gases from the decomposition of water with heated carbon by proper treatment. I do not think there would be any difficulty in getting quit of this gas. No doubt it would considerably add to the expense of the water gas; but in places where coals are expensive, and where lime may be often obtained cheaply, as it frequently crops out at great distances from the coal-field, it might become much more profitable to remove this carbonic acid from the gas by means of the lime than to employ expensive coals. Mr. Skinner further made allusion to hydrocarbons increasing the specific gravities of the gas, and thereby lessening the indications of the meter. I can easily understand him so far as increasing the specific gravity is concerned, because the extra volume of hydrocarbon vapours, being very dense, would increase the specific gravity of the gas; but I cannot understand him so far as difference in the registration of the meter is concerned, because 1000 feet of coal gas and 1000 feet of ordinary atmospheric air having double its volume, on being passed through a meter would, of course, indicate the same volume. In reference to the action of rubber tubing, I am aware that white tubing, from the nature of its manufacture, is not only absorptive, but porous; that a gas passes through it by law of diffusion, or *exosmose*, whereas, generally red rubber tubing is made from a better class of material, and is much less porous, and I think it can be easily understood, seeing white rubber tubing not only barely absorbs the hydrocarbons, but allows them to escape through its pores, that it will have a much greater action upon the illuminating power of a given volume of gas than red rubber tubing, which simply acts by absorbing the hydrocarbon vapours, but that red rubber tubing does not reduce the illuminating power of the gas I am not prepared to admit, because, in making some experiments recently on pneumatic gas, consisting of air impregnated with hydrocarbon vapours, I had occasion to transmit them through a long length of red rubber tubing. This red rubber tubing actually increased in diameter until it was nearly double its original size, showing conclusively that red rubber tubing had the power of absorbing hydrocarbon vapours, and I have no doubt, when careful experiments are made, it will be found that long lengths of red rubber tubing will considerably reduce the illuminating power of the gas, but, perhaps, not to the same extent as by the common white tubing.

It was agreed at this stage to take the further discussion of Mr. Young's paper at the next meeting, which was fixed for September next, in Glasgow.

YIELD OF WELLS SUNK IN THE CHALK OF THE LONDON BASIN.*

By Mr. EDWARD EASTON.

The geology of the London basin has already been most ably and fully described by Professor Prestwich, Mr. Whitaker, Professor Ansted, and others; and it is not proposed to refer to it, except as far as the great divisions of the stratification affect the water-producing power of the basin generally. The two great water-bearing divisions are:—First, the chalk denuded of superincumbent strata (except gravel), which receives the rainfall direct; secondly, the chalk covered by the tertiary deposits, which receives the rainfall, partly from the denuded chalk, and partly after its passage through the pervious beds underlying the London and plastic clays. It is to the consideration of this latter division that the present paper relates, and especially to that portion of it which is situated in the middle of London, within a radius of four or five miles from Charing Cross. The chalk under London is always spoken of as taking the form of a basin; and this is strictly correct, as far as regards both its configuration of surface and lines of stratification along sectional lines from north to south. But it resembles a basin with a lip or spout to it in the other direction from west to east, the spout or outlet being the valley of the Thames below Woolwich, where the river, after passing through the tertiary strata, resumes its course through the chalk itself.

Were it not for two disturbing causes, it would be easy to trace the rainfall from its point of reception into the chalk to its outlet into the Thames, and so on to the sea; and an approximate estimate might be formed of the quantity so passing. But, in the first place, it is very difficult to determine the amount of obstacle offered by the deflection of the chalk to such a depth as it assumes under the tertiary strata—a depth varying from 100 to 300 feet; and, in the next place, there occurs a great fault in the strata on the east of London, which has a very marked effect upon the outflow of the water. It is not possible to describe this fault in shorter or clearer language than that used by Mr. Whitaker:—"The most important fault in the London basin is that along the valley of the Thames below London, with a downthrow on the north sometimes to an extent of about 100 feet, and perhaps more, which may indeed have had some effect in determining the course of part of that valley. It is seen in section in two railway cuttings south of Deptford, is proved by well sections at Greenwich, is lost sight of (under the river ?) at Woolwich, is again shown farther eastward, again lost under the river, and last occurs on the northern side of the Thames near Purfleet and Stifford. In thus attempting to trace this fault for so long a distance, I must be understood to speak with a little doubt, as there are two breaks in the chain, and as on the north of the river the beds are so much hidden by alluvium and gravel. In Mr. Mylne's geological maps of London no such line of fault is shown, but that at Greenwich is made quite distinct from that at Abbey Wood. I was quite unable, however, to trace any such lines of fault as those on Mr. Mylne's map; and it seemed to me much safer to connect the three separate exposures of Greenwich, Abbey Wood, and Stifford in a gentle curved line." Mr. Whitaker further says that "there may be other faults in this disturbed tract" (south-east of London), but that, "acting on the safe principle in geological mapping—not to draw a fault unless it is actually seen," none have been marked on the geological map of England. The fault thus described, combined with the fact of the chalk being disturbed, has caused a sudden alteration in the level of the water in the chalk; for whereas, in the wells in Bermondsey on the south of the Thames, and Whitechapel and Shadwell on the north, the normal level of the water is from 70 to 90 feet below Trinity high-water mark, the wells at Greenwich and those of the Kent Water-Works on the south, and at Grays and other places eastward of the fault of the north side, have their normal water-line generally at about mean-tide level, or about 10 feet below Trinity.

The other disturbing element in the flow of the water, as distinguished from the phenomena to be observed in what the writer will term pure chalk districts (such as the Brighton Downs, for example), is that described by another eminent geologist, Professor Prestwich. With reference, more particularly, to the condition of the chalk underlying the tertiary strata it is evident, in the many movements of elevation and depression which the crust of this part of the earth must have undergone, that those strata which form the immediate surface must have been far more shattered and fissured than those which are covered by a great weight of superincumbent deposits; the one portion would be extensively fissured and creviced, whilst the other would remain comparatively unbroken and entire. Therefore we cannot expect to find in the deep-seated mass of chalk beneath the tertiary strata the same facilities for the transmission of water as those which evidently exist in it where it constitutes the surface of the country. Were it not for these disturbing elements, the flow of water in the chalk under London would doubtless follow more closely the general laws which govern it in pure chalk districts. In the case of Brighton, for instance, the rain which falls on the surface is to a greater or less extent, according to the period of the year, absorbed into the body of the chalk, and finds its way straight to the sea, partly through vertical fissures made during the course of ages in the solid rock itself, and partly along the horizontal lines of flints, which frequently in that district form unbroken beds of very considerable extent. The whole of the rainfall, except that absorbed by vegetation or given off by evaporation, percolates into the chalk, and has its chief outlet into the sea; just as in the case of the London basin its chief outlet would naturally be towards the river Thames at Deptford and below. When the chalk becomes full, the surplus water runs out at springs, which break out all along the great escarpment at the northern boundary of the South Downs at Poynings, Plumpton, and in the Clayton tunnel of the London and Brighton Railway; just as all round London the overflow of the chalk finds its vent in the springs forming the rivers Wandle, Ver, Colne, Wendle, &c. But whereas the main body of water at Brighton runs into the sea underground, and only the surplus water finds its way into the open country, in the case of the London basin there is good reason for supposing that the great bulk of the rainfall on the chalk and the strata feeding the chalk, situated to the westward of the fault above mentioned, runs out at these streams, and that only a comparatively small portion finds its way into the chalk under London. This view is strongly corroborated by the fact that—whereas in London proper, where the chalk is covered with thick tertiary deposits, it is rare to meet with any well which will yield more than from 300,000 to 600,000 gallons daily (there is only one well the writer is acquainted with doing more than this—namely, that of the Government Water-Works, in Orange Street)—the wells and boring of the Kent Water-Works give quantities varying from 1 million to 5 million gallons daily. Speaking generally, the depth of water level in the wells at Brighton was at its maximum in March each year, and the minimum was in October to December; but this was dependent upon the season, it being observed that the curve formed by the depths of the water followed that of the rainfall at an interval of about four months. Very much the same phenomenon takes place in the London basin, where again on the average the lowest time in every year is March, and the highest November to January.

The disturbing causes have produced also another result in the case of the London basin—namely, the uncertainty of finding water in any quantity. This is particularly shown by the difference in the yield of the well at Trafalgar Square and at Coombe and Co.'s brewery in Long Acre, the former giving above 600,000 gallons daily, whereas the latter at the distance of little more than a mile does not afford a supply of one-tenth the amount, although the water level is lowered very considerably more. It is very difficult to determine also how much of the water obtained from the wells sunk through the tertiary strata into the chalk is derived from the chalk itself, and how much from the sands between the plastic clay and the chalk. At many places the quantity from the sands is very much in excess, as for instance at Truman and Hanbury's brewery, where out of a daily yield of 120,000 gallons, only 10,000 gallons, or one-twelfth of the whole, comes from the chalk itself. The writer's opinion is that in every well sunk in the centre of the London basin, where the chalk is covered by the tertiary sands, there is a very considerable admixture of water from these sands with the chalk water proper, if indeed this admixture is not quite general all over the district. The chief reason for coming to this conclusion is that, whilst the analysis of water derived from denuded pure chalk invariably shows a hardness, according to Dr. Clark's test, of from 14° to 18°, arising to a very great extent from the presence of carbonate of lime and to a smaller extent from chloride of sodium, the water obtained from bore-holes or wells sunk through the tertiary strata is generally soft, and varies from 3° to 8°. This does not arise from the absence of mineral matters in solution, so much as from the presence of alkalies, which neutralize the hardening effects of the salts. Thus, whereas the average analysis of pure chalk water would be somewhat as follows:—Carbonate of lime, 13·00 grains per gallon; sulphate of lime, 1·20; chloride of sodium, 2·50; silica, 1·00; total, 17·70, or say 18 grains per gallon, the average analysis of the deep-well water under the tertiary strata would be—Carbonate of lime, 3 to 8 grains per gallon; carbonate of magnesia, 1½ to 2; carbonate of soda, 6 to 18; sulphate of soda, 24 to 6; sulphate of potash, 1 to 13; silica, ½ to 1; chloride of sodium, 10 to 20; total, 46 to 68; or from 40 grains to 70 grains per gallon.

Another point to be observed in connexion with all these wells is that the level of the water in them is steadily lowering, as the sinking of new wells in the district causes a larger amount to be drawn from the strata. This has been observed in nearly every well which has been steadily worked; and several cases are known where wells have become disused, owing to their having run dry. It is evident that no great quantities of water can be expected under London itself, certainly not more in the writer's opinion than will be wanted for manufactories and large consumers; and that any great addition to the general supply of the Metropolis from the chalk must be looked for from the outlying districts where that stratum is denuded.

In the discussion which followed the reading of this paper,

* A paper read at the meeting of Mechanical Engineers on Thursday, May 4, 1876.

Mr. COWPER said he had constructed a section showing the depth of all the deep wells throughout London, and could corroborate Mr. Easton's statement regarding the general level of the water in them. That had been lowered during the last few years 25 feet.

Mr. CLAY asked whether there was any tendency of the salt water to come in from the sea at Brighton. The water in the deep wells in Liverpool, in the sandstone was liable to become salt by the percolation from the estuary. Ultimately they had taken the bore-hole below the level of the river bed, but they still found that the water was perceptibly salter at high than at low water.

Mr. E. SPON was of opinion that there was more than one fault in the chalk running through the Thames basin. That would explain the difference of yield between the adjoining wells. For many reasons there was a great difficulty in ascertaining the actual yield of the London wells, but he thought that 100 gallons a minute was about the largest return from wells in the chalk.

Mr. EASTON, in reply, said that with regard to the depression in level, everybody who had any experience in sinking for water in London, must be aware of that fact. As to Mr. Clay's question, he thought there was no danger of the sea-water affecting the wells at Brighton or Ramsgate, which were sunk at such a gradient that the fresh water from the country behind kept back the sea-water. But if the level of the water in such wells was kept much below the sea-level, they were apt to get an admixture of salt water. He had experienced the difficulty referred to by Mr. Spon, in endeavouring to get reliable information as to the supply from the London wells, so as to make a complete return. Taking the areas of one, two, three, four, and five miles from Charing Cross, it was curious that the supply from each was about the same—namely, about one million gallons per day. With respect to level, it was seldom that the water was allowed to reach its normal height.

IRON AND COAL TRADES OF SHEFFIELD, SOUTH YORKSHIRE, AND NORTH DERBYSHIRE.

(FROM OUR OWN CORRESPONDENT.)

Much satisfaction is felt in the district, now that it is apparent that the miners strike is being gradually broken up, and on account of the probability there is that, in the ensuing week, the majority of the men will again be at work. At Staveley and Clay Cross, where there are in ordinary times over 6000 men employed, the pits have been reopened at a reduction in wages of 12½ per cent. and almost all the men have recommenced their work on those terms. At Shirecoaks, too, where over 1000 miners are employed, large numbers have gone in at precisely the same rates of payment as the above, whilst at Kiveton Park 1500 men have accepted a drop of 10 per cent. At North Staveley and North Wingfield 12½ per cent. is the reduction. These places are mostly in Derbyshire and North Notts, so that so far as those counties are concerned the dispute has virtually terminated. In South Yorkshire the state of affairs is hardly so favourable, but it is felt that if the Thorncliffe men go in, as they are likely to do in the course of the next few days, the remainder will follow their example. The fact of the Central Board of the Miners National Association having voted a grant of 7s. 6d. per man per week, during the strike, somewhat militates against the chances of a full early settlement; but it is nevertheless deemed improbable that any great number of the malcontents will remain out after to-day (Tuesday). On Monday, last week, there were 32,000 miners out, now there are hardly 20,000, and that total is daily growing less. The price of coal in the meantime remains almost stationary, even in household qualities. Steam coal for forward contracts is, as a matter of fact, being quoted at lower figures, and I shall not be surprised if the "list" price be made 9s. next month. For export there is a little better inquiry, and several Yorkshire and Lancashire gas companies are in the market with contracts, which they seek to place at fully 2s. under recent quotations.

The iron trade continues very quiet, and there are no material changes in prices to note. North Yorkshire pig is now held at about the following rates by local agents:—No. 1 foundry, 50s. 6d.; No. 2 foundry, 49s.; No. 3 foundry, 47s.; No. 4 foundry, 46s.; No. 4 forge, grey, 45s. 6d; No. 5 forge, mottled, 45s.; No. 6 forge, white, 44s. 6d.; Refined metal, 65s.; Kentledge, 54s.; and cinder, 39s. Local pig iron is a little stiffer and scarcer, but in the absence of any really good demand prices cannot advance beyond the present limit.

IRON AND COAL TRADES OF SOUTH STAFFORDSHIRE AND EAST WORCESTERSHIRE.

(FROM OUR OWN CORRESPONDENT.)

There is no noteworthy alteration in the condition of the iron trade of this district since last report, and, though considerable dulness still prevails, yet the condition of affairs is better than at the opening of the quarter. Sheets are in decidedly improved inquiry, and in some instances merchants and consumers are replenishing their stocks, in the belief that prices have now receded to the lowest limit; one or two good specifications for merchant iron have been distributed during the past fortnight, but plates are in very limited request. The leading firms continue to quote £9 per ton for bars; plates, £10 10s. per ton; sheets, £11 per ton; and, though the common qualities of finished iron are nominally quoted on the basis of £7 10s. per ton for bars, prices are very irregular, and good specifications may readily be placed on easier terms; few of the mills and forges are running full time, and many are not half employed. Labour in that department of the trade is very plentiful.

For pig iron the market is extremely dull, and, though the total production of pig iron throughout the district has been reduced to something less than 6000 tons per week, stocks continue to increase; large quantities of iron are still being imported into this district from the Northern centres of production, but the leading qualities of native all-mine pig are firm at £4 5s. to £4 10s. per ton for hot-blast, and £5 10s. for cold-blast makes.

Around West Bromwich the leading ironfoundries are busily employed, and some good orders for gasholders and other structural iron-work are now in course of execution. Specifications for purifiers, mains, and other gas-works plant, have been rather freely distributed during the past month, and some of the leading firms are unable to accept further orders for completion this season.

Coal of all qualities is now in very abundant supply, and prices have an easier tendency. At the sinking of the Fair Oaks Colliery Company in the Cannock Chase district, another seam of coal, 4 feet 10 inches thick, has been passed through this week, making the fourth seam passed since the boring operations were commenced on that estate.

THE LANCASHIRE COAL AND IRON TRADES.

(FROM OUR OWN CORRESPONDENT.)

Round coal in this district still meets with very little inquiry, except for house fire purposes, and although there has been no alteration in the list quotations, prices continue weak. Where sales in bulk are made, holders very readily make considerable concessions; and the ordinary market quotations are of very little value except so far as small retail transactions are concerned. The average pit prices in the Wigan district for coal remain at about 11s. to 11s. 6d. for best Arley, 9s. to 9s. 6d. for Pemberton four-feet, and 7s. to 7s. 6d. per ton for common coal. Good classes of burgy and slack meet with a very fair demand for brick-making, and the latter class of fuel being scarce, rather higher prices are obtained without difficulty. Burgy, at the pit mouth, is quoted at about 6s. per ton, slack at from 4s. to 5s., and in some cases 5s. 3d. per ton is asked.

In the gas coal trade, a few sales have been reported in the Manchester market during the past week, and the quotations at the pit mouth in the above district are about 18s. per ton for cannel, 11s. for best screened, and 7s. 6d. to 8s. per ton for best unscreened gas coal; but for good orders concessions on these figures could be obtained without much difficulty. I do not hear of much having yet been done in other districts, although there are inquiries still in the market.

The demand for coke continues only very limited, and quotations, which are little more than nominal, may be given at about 20s. for Lancashire and 22s. for best Durham foundry cokes delivered into the Manchester district.

The shipping trade is still very inactive, and notwithstanding that very low prices are ruling at Liverpool, orders are exceedingly difficult to obtain.

Strikes continue at several of the pits in the Manchester district, and the colliery proprietors at Atherton have made an effort to fill the places with men from Staffordshire, but with very little success, as the new comers were induced to return home by those on strike.

The iron market shows no improvement, and although it is only in a few odd cases that Lancashire pig iron is being sold at any material concession upon late prices, Middlesbrough brands can be bought for less money. The average quotations for delivery into the Manchester district are about as under:—Lancashire, 60s. per ton for No. 3 foundry, and 59s. for No. 4 forge; Middlesbrough, 55s. 3d. to 55s. 9d. for No. 3 foundry, and about 1s. less for forge qualities. In manufactured iron there is scarcely any inquiry, and the nominal prices are about £7 5s. for ordinary Lancashire, and £7 10s. for Staffordshire bars delivered into the district; but orders could be placed without difficulty at 2s. 6d. per ton below these figures.

THE COAL AND GENERAL TRADE OF THE NORTH OF ENGLAND.

(FROM OUR OWN CORRESPONDENT.)

The wind having got round to the south-east, there will, probably, be a large arrival of light coasting vessels in the coal ports by the time this report is published. It also will be very likely that there will be a fall in the value of coasting freights at the same time. Through a scarcity of handy vessels, there was an advance of about 10s. per keel in coasting rates last week. Small vessels were difficult to procure; and through a scarcity of ready tonnage, some orders could not be executed, and fewer coals were shipped last week than the week before, in consequence.

There was a moderate demand for gas coals, and a falling off in shipments. Prices were from 7s. to 9s. per ton. A good deal of inferior gas coal has been sold from 7s. to 7s. 6d. a ton; best, 8s. 6d. to 9s.; best Tyne households are offered at 12s. a ton, and the best qualities of steam coals realize from 11s. 6d. to 12s. 6d. a ton. The pits are working satisfactorily, and the outputs from the collieries are fully an average. Coal turns are steady, steam turns average a week, gas coal rather longer, house and manufacturing coals with coke shipments somewhat less. The freights paid to steamers to London from the Tyne are 4s. 6d. to 5s. per ton; to Rochester, 4s. 9d.; Rouen, 7s. 6d. per ton; and Hamburg, £6 10s. a keel.

The iron trade of the North of England gets no better. The manufacturing iron business is in a very depressed state; a good few gas and water pipes, however, are being shipped, but in other respects there is very little doing. The unsettled position of the Eastern Question is having a bad effect upon the business of the North of England generally, as merchants decline to enter upon new undertakings, and merely give out orders to meet immediate wants.

The chemical trade of the Tyne and the North of England shows no improvement. The market was very weak at Newcastle on Saturday, and prices were tending lower. Nothing scarcely is doing in chemicals to the United States.

TRADE NOTES FROM SCOTLAND.

(FROM OUR OWN CORRESPONDENT.)

It seems that Sir Windham Anstruther's Burghs (Scotland) Gas Supply Bill is still the subject of contending interests, and that some of its friends fear lest the disagreement of those interests should prevent the measure in any shape passing through Parliament this session. The bill, in its amended form, is not quite acceptable to the Corporation of Glasgow, and it was suggested a few days ago that the select committee of the House of Commons might consent to review their labours in the direction desired. Accordingly, it was again brought before the House in the "small hours" of Friday morning by Sir W. Anstruther, who moved that the order for the committee be discharged for the present, in order that the measure might be referred back to the select committee. After some remarks by Mr. Raikes and Sir Edward Colebrooke, the motion was agreed to.

On Wednesday last a meeting of the Brechin Gaslight Company was held for the purpose of considering various alterations proposed to be made in the contract of co-partnery, and one, at least, of which has excited a strong opposition in the community. Hitherto, the stock of the company has been divided into 540 £5 shares, on which, for a number of years, a dividend of 10 per cent., with a bonus of 1 per cent., has been paid. At Wednesday's meeting, it was proposed that the whole shares of the company should be declared to be of the value of £10, thereby increasing the capital stock to £5400. Previous to the meeting taking up the proposal, a deputation from a meeting of large consumers in the town was heard in opposition to it. The deputation all spoke strongly against the proposed doubling of the value of the shares, and stated that, if it was done, an opposition gas company would be started. After the deputation withdrew, it was moved that the value of the shares be £10. An amendment was moved that the shares remain unaltered. On a division, 119 voted for the motion, as against 42 for the amendment, and the former was, therefore, declared carried.

There is every probability of the price of gas being further reduced in Perth this year. Last year the price was reduced from 7s. 1d. to 5s. 5d. per 1000 cubic feet—being a reduction of 1s. 8d.—and it is fully expected that at the next meeting of the Corporation Gas Commissioners, the Works Committee will recommend a further reduction of 10d. per 1000 cubic feet, thus making the price 4s. 7d. to ordinary consumers. This will make the price 1s. 3d. per 1000 feet less than ever it has been since the gas supply came into the hands of the Town Council, and it may be taken as an indication of the efficient way in which the works are managed.

The directors of the Newport (Dundee) Gas Company have resolved to adopt a plan for turning to the utmost account every inch of ground in the present works. The chief feature of this is the replacement of the small gasholder, which is 30 feet in diameter and 8 feet in depth, by a new one of 42 feet in diameter and 16 feet in depth, the capacity of the storeage being thus raised from 5600 cubic feet to 21,000 feet. Other changes and additions will be made to equip the works for the necessary increase of production, and the total cost will be upwards of £1200. It is calculated that the contemplated enlargements will enable the company to supply gas to all the houses within the limits to which they intend to confine their operations.

The annual general meeting of the Falkirk Joint-Stock Gas Company was held last Tuesday—Mr. William Wyse in the chair. The balance-sheet, with the usual relative statements, was submitted, as also the directors report, which recommended a dividend of 4 per cent. on the extended capital of the company, to be payable on the 1st of June next. It also stated that arrangements had been made for the erection of a new gasholder and tank at Bankside, to hold 100,000 cubic feet of gas. The report was approved of, and the directors for the next year were elected.

At the monthly meeting of the Forfar Gas Commission, held last Monday night, a proposal to erect additional retorts, so as to increase the manufacturing capabilities, was submitted, but as some opposition was raised, it was resolved that the further consideration of the matter should be delayed for a month. In terms of a recommendation by the Works Committee, it was agreed that the gas for the street-lamps should be charged at the rate of 2½ cubic feet per hour.

Dr. Wallace's testings of the Glasgow gas for the week ending May 13, show that in no instance was the illuminating power below the statutory minimum of 25 standard candles. The minimum ranged from 25·01 candles to 28·53 candles, and the maximum from 27·11 to 30·22 candles. Both as regards the sulphur and ammonia impurities there was a decided improvement.

On the 20th ultimo, when the public analyst for Edinburgh made an examination of the gas supplied to the city, he found that the gas of the Edinburgh Company had an illuminating power of 29·28 candles, while that supplied by the Edinburgh and Leith Company stood at 27·39 standard candles.

The value of the Glasgow Corporation Gas Annuities (9 per cent.) was advanced 10s. last Wednesday, and a few days ago, an annuity debenture for £30 14s., by the commissioners under the Dundee Gas Act, 1868, was sold at almost 24 years purchase, for the sum of £725.

The Carluke Local Authority have at present under consideration a report upon what is called the Springfield Water Scheme, by Mr. James Tait, C.E. He reports a good supply of water there at all seasons, and estimates that the springs would yield 146,000 gallons per day, or one-half more than the present requirements. It is proposed to secure ground near Croftfoot for a reservoir. The estimated cost of this scheme is set down at £4684 10s., and another one, known as the Badshaw scheme, is estimated to cost £4657.

The Campbeltown Burgh and Harbour Bill inquiry was brought to a termination by the House of Commons select committee last Tuesday. In respect of the matter in dispute—the water supply—the Duke of Argyll was, in a measure, the victor. He is still to charge the distillers for the water which they require; but the promoters of the bill have succeeded in reference to their proposal to acquire works for the domestic supply of the town.

A good deal more animation was shown in the Glasgow pig iron market on Thursday than in the early part of the week, and a fair business was done at 57s. 10½d., one month fixed, to 58s. 4½d., one month open. Friday's market was strong, both forenoon and afternoon, and as high as 58s. 6d. was paid. Several makers advanced their prices 1s. to 2s. per ton.

Little or no alteration can be reported regarding the condition of the Glasgow coal market. Foreign shipments continued on a very extensive scale at the Fifeshire ports, and are large enough to prevent any storing at the pits. The home trade, however, is very dull.

Register of New Patents.

APPLICATIONS FOR LETTERS PATENT.

1697.—Porter, J. H., Lavenham, Suffolk, "Improvements in filtering water, and in the apparatus employed therein." April 21, 1876.

1730.—Stannah, J., Southwark, London, "Improvements in donkey engines and pumps." April 24, 1876.

1738.—Pearn, F. and S., Manchester, "Improvements in steam-pumps, and in valves used in connexion therewith." April 25, 1876.

1739.—Bannehr, J., Gray's Inn, London, and Varley, S. A., Hatfield, Herts, "Improvements in means for intercepting and treating excreta and other matters of sewage, parts of which improvements are also applicable to other purposes." April 25, 1876.

1740.—Blackie, J. K., Glasgow, and Robertson, J., Govan, Lanark, "Improvements in service cisterns and valves for regulating the supply of water for water-closets and other purposes." April 25, 1876.

1765.—Grayson, J., Hunter Street, and Clarke, S., South Lambeth Road, London, "Improvements in apparatus for the manufacture of gas." April 26, 1876.

1778.—Haddan, H. J., Strand, London, "Improvements in and in apparatus for lighting conveyances." A communication. April 27, 1876.

1783.—Muller, J. A., Amsterdam, "The manufacture of gas and fuel from rice husks." April 27, 1876.

1789.—Almgill, T., Manchester, "Improved apparatus for measuring water and other liquids." April 28, 1876.

1811.—Erskine, F., Manchester, "Improvements in or applicable to steam boiler and other furnaces for consuming smoke, also partly applicable to the manufacture of gas, to ventilating mines, and for utilizing and purifying noxious vapours and gases, and rendering the same innocuous and non-explosive." April 29, 1876.

1823.—Watkinson, R., and Stafford, T., Salford, Lancs, "An improved universal joint for coupling pipes." May 1, 1876.

1827.—Hughes, E. T., Chancery Lane, London, "A new or improved gas-light extinguisher." A communication. May 1, 1876.

1831.—Clark, A. M., Chancery Lane, London, "Improved apparatus for charging gas-retorts." A communication. May 1, 1876.

PATENTS WHICH HAVE PASSED THE GREAT SEAL.

3541.—Melvin, T., Glasgow, "Improvements in engines to be driven by steam, water, or other fluid, or for pumping." Oct. 12, 1875.

3827.—Mathews, T., Tottenham Court Road, London, "Improvements in meters or apparatus for measuring and indicating the flow of fluids." Nov. 3, 1875.

3828.—Vacherot, A., Battersea, London, "Improvements in rotary engines, rotary pumps, and other like apparatus." Nov. 3, 1875.

3838.—White, W., Abersychan, Mon., "Improvements in apparatus used in the manufacture and distribution of gas." Nov. 4, 1875.

3850.—Bennett, J. T. B., Birmingham, "An improved retort, and arrangements of retorts, for manufacturing gas, and other purposes." Nov. 5, 1875.

3867.—Neuhaus, M., and Hodgkin, J. E., Queen Victoria Street, London, "Improvement in steam-pumps, parts of which improvements are applicable to other similar purposes." A communication. Nov. 6, 1875.

3928.—Jackson, J. and T., Hyde, Chester, "Improvements in the construction of injectors, ejectors, and ejector condensers." Nov. 11, 1875.

4065.—Pothetos, A., Greece, "Improvements in apparatus for, and in the means of raising water." Nov. 23, 1875.

4521.—Wernekinck, E., Berlin, "A new or improved motor impelled by compressed air or other fluid or liquid." Dec. 29, 1875.

4526.—Clark, A. M., Chancery Lane, London, "An improved trap and grating for drain and sewer inlets." A communication. Dec. 29, 1875.

7.—Beaumont, F. E. B., Victoria Street, London, "Improvements in motor engines worked by compressed air or other elastic fluid under high pressure." Jan. 1, 1876.

13.—Rawson, C., Westminster, and Slater, J. W., Tamworth Terrace, London, "Improvements in deodorizing and purifying sewage." Jan. 1, 1876.

87.—Payton, W., Hammersmith, and Holmes, J. E., Bayswater, London, "Improvements in engines to be actuated by steam, air, or other fluid, also applicable for raising and forcing liquids." Jan. 7, 1876.

137.—Law, H., Adelphi, London, "Improvements in air vessels, valves, and regulators for the supply of water to water-closets, urinals, and lavatories, which are also applicable to other purposes." Jan. 13, 1876.

188.—Steel, J., Glasgow, "Improvements in the manufacture of gas, and in the machinery or apparatus employed therefor." Jan. 18, 1876.

426.—Laidlaw, D., Glasgow, "Improvements in lighting railway carriages, and in the mechanism or apparatus employed therefor, the same being applicable for lighting tramway cars, ships, factories, and other buildings." Feb. 2, 1876.

983.—Lake, W. R., Southampton Buildings, London, "Improvements in gasaliers." A communication. March 7, 1876.

PATENTS WHICH HAVE BECOME VOID

BY REASON OF THE NON-PAYMENT OF THE ADDITIONAL STAMP DUTY OF £100 BEFORE THE EXPIRATION OF THE SEVENTH YEAR.

1177.—Harrison, S., "Improvements in apparatus and arrangement of same for ventilating, gaining access to, and flushing street and other sewers and drains, also in purifying the noxious gases arising therefrom, parts of which improvements consist in gully stench-traps." April 16, 1869.

The GRAND MEDAL of MERIT at the VIENNA EXHIBITION has been AWARDED to

GWYNNE & BEALE'S PATENT IMPROVED GAS-EXHAUSTERS,

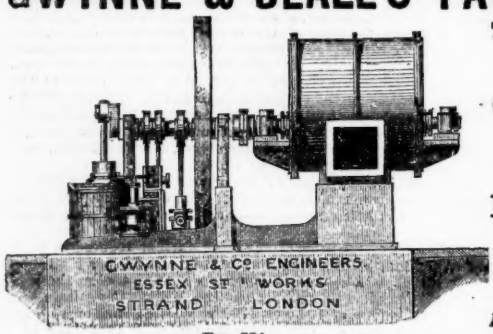


FIG. 224.

The BEST EXHAUSTERS IN THE WORLD.

GWYNNE & CO. HAVE MADE THE LARGEST AND MOST PERFECT EXHAUSTING MACHINERY Ever produced, and the most economical in working.

Prices and every information on application.

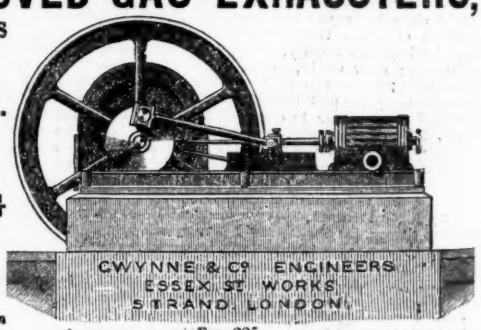


FIG. 225.

Fig. 224 represents one of those erected at the Imperial Gas-Works, Bromley, capable of passing 210,000 cubic feet of gas per hour. Several others of the same size are now on order for the same Company. These Patent Machines combine the highest quality of workmanship and materials, the largest bearings and wearing surfaces, with the **most perfect system of action yet discovered.** Fig. 225 represents one of a series of four at the Nottingham Gas-Works, each passing 52,500 cubic feet per hour. GWYNNE AND Co. *do not pretend to enter into a struggle with other makers in respect to cheapness. They have never sought to make price the chief consideration, but to produce Machinery of the very highest quality, and the most approved design and arrangement.* Their prices have been estimated with a due regard to the **excellence of the article produced,** and when this is taken into consideration, they have no fear for the result. The orders executed this season for Exhausters and alterations to their patented system amount to over 4,000,000 cubic feet of gas passed per hour, and to over 300 horse power for Engines to drive them. In every instance their work is giving the greatest satisfaction. Numerous testimonials and references can be given.

REGULATORS, BYE-PASSES, STOP-VALVES, GAS-VALVES, & MACHINERY FOR GAS MANUFACTURE, OF ALL SIZES, CAN BE HAD ON APPLICATION TO

GWYNNE & CO., HYDRAULIC & GAS ENGINEERS, ESSEX STREET WORKS, STRAND, LONDON, W.C.

G. & Co. are now manufacturing for a London Gas Company three of their 210,000 cubic feet Patent Gas Exhausters, and many of all sizes.

D. BRUCE PEEBLES & CO.,

ENGINEERS,

FOUNTAINBRIDGE WORKS, EDINBURGH,

MANUFACTURERS OF **WET AND DRY GAS-METERS;**

Patentees and Sole Manufacturers of PEEBLES' LAMP-GOVERNORS,

ABOVE 30,000 OF WHICH ARE NOW IN USE.

"These Lamp-Governors are so superior that they are likely to supplant all others."—*Dr. Wm. Wallace, F.R.S.E., F.C.S.*

D. BRUCE PEEBLES AND CO., FOUNTAINBRIDGE WORKS, EDINBURGH.

TRAVELLERS.

WANTED, one or two good Men to represent a first-class Meter Company.
Address No. 266, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, by the Advertiser, aged 32, a situation as METER-INSPECTOR, Fitter, Index Taker, Service Layer, &c. Abroad preferred.
Address BETA, care of Mr. Smith, 60, Cornwall Road, Lambeth, LONDON, S.E.

WANTED, a situation as Working MANAGER in a small country GAS-WORKS. Is thoroughly acquainted with the manufacture and distribution of gas. Twenty years experience. Eleven years in present situation.
Address T. CRESSWELL, Gas-Works, Cuckfield, SUSSEX.

WANTED, by a thoroughly practical Man, a re-engagement as manager of a Gas or Gas and Water Works. He is well experienced in every department; keeping accounts, and carrying out extensions and alterations. Good testimonials and references.
Address No. 264, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

FOREMAN WANTED.

WANTED, a thoroughly experienced FOREMAN in a provincial Gas-Works, where the annual make is about 250 millions. He must be intimately acquainted with carbonizing, also have a good general knowledge of retort-setting.
Applications, in own handwriting, stating age, experience, wages required, and references, to be sent not later than the 1st of June, addressed to No. 263, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, by a thoroughly practical Man, who will shortly be disengaged, a re-engagement as MANAGER of a Gas or Gas and Water Works. Is well experienced in every department. Can produce first-class testimonials and references.
Address No. 265, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, a situation as Assistant MANAGER or INSPECTOR. Has had several years experience as Inspector in a London works; also four years in present country works as Assistant Manager. Understands thoroughly all branches connected with the distribution of gas. Good references.
Address, W. THOMAS, 3, St. Mary's Terrace, St. Mary's Square, PADDINGTON.

CANTERBURY GAS AND WATER COMPANY.

WANTED, a strong working Man as STOKER and Second Engineer for the Water-Works. Candidates must have a knowledge of machinery, and be capable, when required, of taking charge of the works.
Applications, stating age, and wages required, together with testimonials, to be delivered to me on or before the 1st of June next.
JAMES BURCH, Secretary.
Canterbury, May 19, 1876.

TO IRONFOUNDERS AND OTHERS.

THE Directors of the Torquay Gas Company are prepared to receive TENDERS for the supply of about 700 yards of 15-in. SOCKET-PIPES.
Specification and particulars may be obtained on application to the undersigned, to whom tenders should be sent on or before Thursday, the 1st of June next.
JAMES GREENFIELD, Manager.

ADVANTAGES OF GAS FOR

COOKING AND HEATING.

HINTS ON GAS BURNERS, &c.

By MAGNUS OHREN, A.I.C.E., F.C.S.

Specimen Copy by post Threepence, direct from MAGNUS OHREN, Gas-Works, Lower Sydenham, London, S.E.

A Young Man wishes for a situation as GAS-FITTER and Service-Layer. He has a thorough knowledge of index-taking. Good references.
Apply to W. C. GURNEY, Bedford Cottage, Acre Road, Kingston-on-Thames, SURREY.

RAMSAY'S NEWCASTLE CANNEL COAL.

Analysis and Report by Mr. John Pattinson, F.C.S., Analytical Chemist and Gas Examiner to the Newcastle-upon-Tyne Town Council.

Laboratory and Assay Office, 75, The Side,
Newcastle-on-Tyne, April 21, 1876.

I hereby certify that I have examined a sample of Ramsay's Newcastle Cannel Coal, received from G. H. Ramsay, Esq., and that I find the following results:—

On subjecting the sample to distillation in a coal-testing apparatus, 12,000 cubic feet of gas were obtained per ton, having an illuminating power equal to 28·0 standard sperm candles when burnt through a No. 7 Bray's Union Jet Burner.

The Coke assay gave as follows:—

Coke	66·70 per cent.
Volatile Matters	33·30 ,,
Total	100·00 per cent.

The Coke is of good quality.

A complete ultimate analysis was made of the sample, and the following results obtained:—

Carbon	78·62 per cent.
Hydrogen	5·39 ,,
Oxygen	4·81 ,,
Nitrogen	0·88 ,,
Sulphur	0·71 ,,
Ash	9·06 ,,
Water	0·53 ,,
Total	100·00 per cent.

All the above results show that this is a very valuable coal for gas-making purposes. The yield of gas is large, and the illuminating power high. There is less than the average amount of sulphur, and the coke is of good quality.

JOHN PATTINSON, F.C.S.,
Analytical Chemist and Gas Examiner to the
Newcastle-upon-Tyne Town Council.

ON SALE—One Round Station-Meter, to pass 12,000 feet per hour, with 8-in hydraulic valves and bye-pass. Will be thoroughly overhauled and fitted with new drum. Also one 8-in. Anderson's Exhauster, with four driving pulleys, wall-box, &c.
Apply to J. AND J. BRADDOCK, Globe Meter-Works, OLDHAM.

FOR SALE—One 9-in. Governor, by Milne, with or without valves and connexions.
One 6-in. CONDENSER, 24 pipes with bends and flanges at top and syphon-box at bottom, 2 ft. 3 in. by 2 ft. and 14 ft. long.
The above are in first-rate condition, and may be seen at work. Are being removed to make room for larger.
Apply to JOHN CHEW, Corporation Gas-Works, BLACKPOOL.

GAS-WORKS FOR SALE, in one of the most rising seaport towns in Sweden, with the exclusive right of supplying the town with gas and gas-fittings during the remainder of the concession, now about 14 years. The town has the option, at the end of that term, of purchasing the works at a valuation, or renewing the concession for ten years. The price of gas, as limited by the concession, is 6s. 8d. per 1000 for public lamps, and 8s. 4d. per 1000 for private consumers. There is a ready sale for products at remunerative prices. Coals may be got from Newcastle at a lower freight than to London, and there are no coal dues.
For further particulars apply to Mr. RICHARD GLOVER, 214, St. John Street, CLERKENWELL.

GEORGE ORME & CO.,

ATLAS METER-WORKS, OLDHAM,

MANUFACTURERS OF

WET AND DRY GAS-METERS,

STATION-METERS, GOVERNORS,

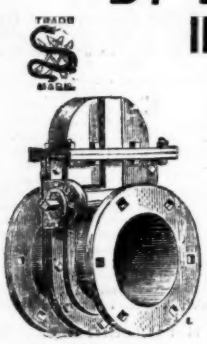
PRESSURE AND EXHAUST REGISTERS,

LAMP-METERS IN CAST-IRON BOXES,

And every Description of Gas Apparatus.

B. DONKIN & CO.'S

IMPROVED GAS-VALVES



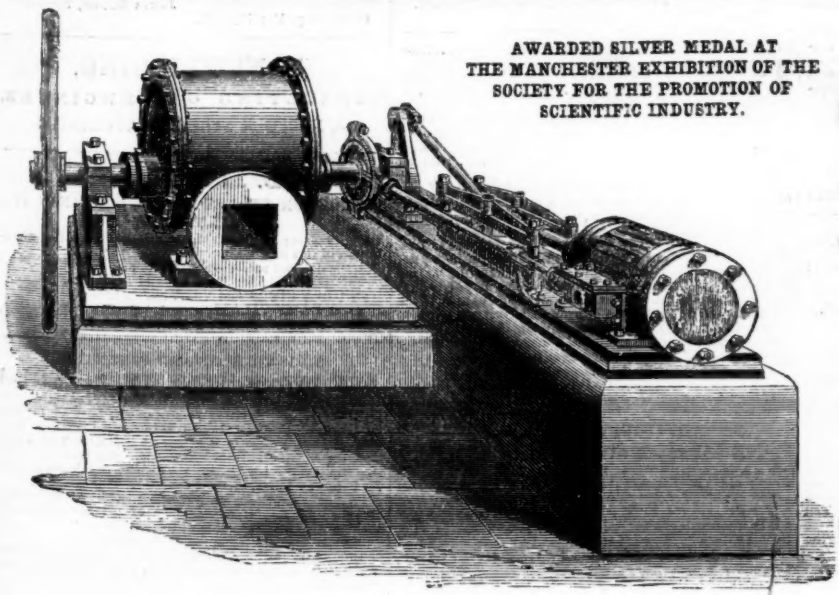
WITH WROUGHT-IRON PINIONS,

List of prices, with full dimensions of all sizes up to 48-inch, to be had on application.

These Valves are all proved on both sides to 30 lbs. on the square inch before leaving the works, and are always kept in stock.

VALVES MADE WITH OUTSIDE RACKS TO ORDER.
ALSO, SCREW WATER-VALVES WITH GUN-METAL FACES.
ALSO SOLE MAKERS OF
J. BEALE'S NEW PATENT GAS EXHAUSTERS.

B. DONKIN & CO.,
GENERAL ENGINEERS AND IRONFOUNDERS,
MAKERS OF STEAM-ENGINES,
55a, BLUE ANCHOR ROAD, BERMONDSEY,
LONDON, S.E.



AWARDED SILVER MEDAL AT THE MANCHESTER EXHIBITION OF THE SOCIETY FOR THE PROMOTION OF SCIENTIFIC INDUSTRY.

BEALE'S

Improved Patent

GAS-EXHAUSTERS

WITH

ENGINES COMBINED.

Sole Makers,

GEORGE WALLER & CO.

Makers of
ENGINES, EXHAUSTERS,
INDEX and DISC GAS-VALVES,
HYDRAULIC MAIN VALVES,
BYE-PASS VALVES,
TAR, LIQUOR, and other PUMPS,
SCRUBBERS and PURIFIERS,
CONDENSERS, BOILERS, &c.

PHŒNIX ENGINEERING WORKS,
HOLLAND STREET, S.E.,
AND
STROUD, GLOUCESTERSHIRE.

STATION-METER for Sale, in good condition (Makers West and Gregson), in very ornamental case, fitted up with tell-tales, inlet, outlet, and bye-pass valves, and 12-in. connexions. Passes 25,000 cubic feet per hour. Now replaced with a larger one.

For price, &c., apply to JOHN W. WHITAKER, Manager, Gas-Works, WAKEFIELD.

RED HILL GAS-WORKS, SURREY.

FOR SALE—15 cast-iron D Mouthpieces, 14 in. by 12 in., fitted with wrought-iron lids; also the ascension, bridge, and dip pipes complete, all 3 in. diameter.

Also one 12-in. Cast-Iron HYDRAULIC MAIN. All in good condition.

Applications to be made to CHAS. READ, Secretary and Manager.

THE Swansea Gaslight Company have for immediate SALE, the following Plant:—

A 6-h.p. Patent Trunk Engine. (Beale.)

Cylindrical Egg-ended Boiler, 20 ft. by 4 ft. 6 in. (Beale.)

Exhauster to pass 15,000 feet per hour. (Beale.)

An 8-h.p. Grasshopper Engine. (Easton and Amos.)

Cylindrical Egg-ended Boiler, 20 ft. by 4 ft. 6 in. (Easton and Amos.)

Exhauster, 20,000 ft. per hour. (Beale.)

Tar, Liquor, and Water Pumps, Eccentrics, Shafting, and Driving Pulleys.

Wrought-iron Condenser, six vertical Legs, 30 ft. high, 24 in. by 6 in., with tar-boxes, dips, and syphons.

Wrought-iron Scrubber, 5 ft. diameter, 20 ft. high.

Cast-iron Scrubber, 3 ft. diameter, 20 ft. high.

A set of four cast-iron Purifiers, 12 ft. square by 5 ft. deep, with galvanized wrought-iron covers, lifting apparatus, four tiers of wooden sieves, 10-in. connexions and valves.

May be seen at the Gas-Works, Swansea. The whole in perfect working order; replaced by plant of larger dimensions.

Further particulars may be obtained on application to Mr. THORNTON ANDREWS, SWANSEA.

TO TAR DISTILLERS AND MANUFACTURING CHEMISTS.

THE Directors of the West Kent Gas Company invite TENDERS for the surplus TAR at their Crayford Works, Kent (say, 20,000 gallons), for One, Two, or Three years, to be filled into Contractor's casks at the works. Contractor to have supply of casks at works within seven days notice of their being required.

The Directors do not bind themselves to accept the highest or any tender.

Tenders, addressed to the SECRETARY, 237, SOUTHWARK BRIDGE ROAD, to be delivered on or before May 31, 1876.

THE Chatteris Gas Company are pre- pared to receive TENDERS for 440 yards of 6-in. turned and bored SOCKET-PIPES, not to exceed 86 lbs. to the yard. To be delivered, with three syphon-boxes, at the Chatteris Station.

Tenders are also required for SHEETING a GAS-HOLDER, 28 ft. by 10 ft. Eight bottom and four top rollers and brackets, with four T-iron girders for top of column, and four T-plates to fit column, 7-in. base with 3-in. face.

Tenders to be sent in to Mr. A. SWABEY, the Manager, on or before May 29.

THE Directors of the Exeter Gaslight and Coke Company are prepared to receive TENDERS for the supply of the necessary IRONWORK for six through benches of Retorts, with wrought-iron Hydraulic Main, &c.

Plans, specification, and conditions of the same, may be seen on application to the Engineer at the Basin Works, and tenders, endorsed "Tender for Retort Ironwork," to be sent to me, the undersigned, on or before Monday, June 5, 1876.

By order,
W. A. PADFIELD, Secretary.

Gaslight Offices, Exeter, May 18, 1876.

THE Director of the Catalana Gas Com- pany of Barcelona is prepared to receive TENDERS for a Telescope GASHOLDER, Wrought-Iron Columns, and Girders, all free on board in any port.

The Gasholder being of a capacity from 8000 to 10,000 cubic mètres, and working under a pressure of about 80 millimètres.

Plans and specifications, with terms, to be submitted to the said Director, Mr. José Gil, at 13, Calle Ancha, Barcelona, Spain, on or before the 10th of June next.

The Director does not bind himself to accept the lowest or any tender, and reserves to himself the right of accepting the whole or any portion of one tender.

EBBW VALE LOCAL BOARD.

WATER-WORKS.

THE above Local Board invite Tenders for supplying and laying HOUSE SERVICES from the mains to about 2000 houses.

Copy of specification from Mr. Samuel Oakes Harpur, Engineer, Ebbw Vale.

Tenders to be sent in to me, the undersigned, on or before the 29th of May next.

Dated this 12th day of May, 1876.

JOHN E. WARD, Clerk to the Board.

Newport (Mon.).

SOUTHWARK & VAUXHALL WATER COMPANY.

THE Directors of this Company are prepared to receive TENDERS for the supply of LABOUR, and use of Tools and Implements to be employed in removing, washing, and reinstating the filtering medium at their works at Battersea.

Specification and form of contract may be seen at the Company's Office, Sumner Street, Southwark, on and after Monday, the 15th inst., and sealed tenders, endorsed on the outside "Tender for Labour, &c., Battersea," and addressed to the Chairman, must be delivered before Ten a.m. on Thursday, the 18th inst.

The Directors do not bind themselves to accept the lowest or any tender.

ALFRED JELLEY, Secretary.

May 12, 1876.

WARE GASLIGHT AND COAL AND COKE COMPANY, LIMITED.

THE Directors of this Company invite TENDERS for the supply of 900 tons of New Pelton or Pelaw Main Gas Coal, to be delivered at Ware at such times and in such quantities as may be directed by the Company during the year ensuing the 29th of September, 1876.

Sealed tenders, endorsed "Tender for Coal," to be sent to Mr. G. H. GIBBY, Baldock Street, WARE, before the 12th of June next.

The Directors will not be bound to accept the lowest or any tender.

TO GASHOLDER MAKERS.

THE Birkenhead Improvement Commis- sioners invite TENDERS for the construction of a Wrought-Iron ANNULAR TANK, 152 ft. diameter, and 31 ft. 6 in. deep.

Also for a Telescopic GASHOLDER, 130 ft. diameter and 60 ft. deep.

Plans and specifications may be seen on application to the Engineer, at the Gas-Works.

Tenders, addressed to the Chairman of the Gas and Water Committee, 50, Hamilton Square, Birkenhead, to be sent in on or before the 26th inst.

The tenders must be given in for Tank and Gasholder separately, and be marked on the envelope "Tender for Tank or Gasholder."

The Commissioners do not bind themselves to accept the lowest or any tender.

By order,
AMBROSE WALN, Clerk to the Commissioners.

Commissioners Offices, Birkenhead, May 11, 1876.

STOCKPORT BOROUGH GAS-WORKS.

TO CONTRACTORS, BUILDERS, AND OTHERS.
CONTRACT NO. 3.

THE Gas Committee of the Corporation of Stockport are prepared to receive TENDERS for the building of a RETORT-HOUSE, 145 ft. long and 64 ft. wide in clear; also a PURIFIER-HOUSE, 106 ft. long and 61 ft. wide in clear.

CONTRACT NO. 4.—The Gas Committee are also prepared to receive TENDERS for the building and completion of a CHIMNEY, 70 yards in height, for their new works, Portwood, Stockport.

Drawings and specifications may be seen upon application at the Heaton Lane Works, Stockport.

Sealed tenders to be sent in on or before Wednesday, the 31st of May, addressed to the Chairman of the Gas Committee, and endorsed "Tender for Retort-House, &c.," and "Chimney."

Tenders must be upon forms supplied by the Gas Committee, signed by the contractor tendering, and properly witnessed.

The Committee do not pledge themselves to accept the lowest or any tender.

Further particulars may be obtained from the Engineer.

By order,
JAS. JACQUES, Engineer and Manager.

Millgate Works, May 18, 1876.

STOCKPORT BOROUGH GAS-WORKS.

TO ENGINEERS, IRONFOUNDERS, AND OTHERS.
CONTRACT NO. 5.

THE Gas Committee of the Corporation of Stockport are prepared to receive TENDERS for the supplying and fixing, complete, of two Wrought-Iron ROOFS; viz., one for Retort-House, 145 ft. long and 64 ft. wide in clear; also one for Purifier-House, 106 ft. long and 61 ft. wide in clear.

CONTRACT NO. 6.—The Gas Committee are also prepared to receive TENDERS for the supplying and fixing of GIRDERS, COLUMNS, &c., for the floor of Purifier-House, for their new works, Portwood, Stockport.

Drawings and specifications may be seen upon application at the Heaton Lane Works, Stockport.

Sealed tenders to be sent in on or before Wednesday, the 31st of May, addressed to the Chairman of the Gas Committee, and endorsed "Tender for Roofs of Retort-House and Purifier-House," and "Columns, Girders, &c."

Tenders must be upon forms supplied by the Gas Committee, signed by the contractor tendering, and properly witnessed.

The Committee do not pledge themselves to accept the lowest or any tender.

Further particulars may be obtained from the Engineer.

By order,
JAS. JACQUES, Engineer and Manager.

Millgate Works, May 18, 1876.

TO CONTRACTORS, IRONFOUNDERS, & OTHERS

TENDERS are required for the following WORKS, for ISAAC HOYLE, Esq., and Another, at Summerseat, near Manchester.

CONTRACT NO. 1.—The erection of the buildings of a new Gas-Work, consisting of a retort-house and chimney, coal-store, purifying and lime house, meter-house, governor-house, tar well, and two gasholder-tanks, &c., with all excavation.

CONTRACT NO. 2.—The construction and erection of two Gasholders, each 40 ft. diameter and 16 ft. deep, with guide framing, &c., complete, and the iron roofs of the different buildings.

CONTRACT NO. 3.—The supply and erection of the Iron Work of a retort-bench, condenser, scrubber, purifiers, &c.

The specifications and drawings may be seen at my Offices. Copies of the several specifications may be had on payment of one guinea each, and the amount will be returned on receipt of a *bonâ fide* tender.

Sealed tenders, on forms to be had on application, to be sent to me, on or before the 1st of June, endorsed "Tender for Gas-Works," and the number of the contract.

The lowest or any tender not necessarily accepted.

T. NEWBIGGING, Gas and Consulting Engineer.

5, Norfolk Street, Manchester, May 12, 1876.

CONTRACT FOR COAL, &c.

THE Directors of the Preston Gas Com- pany are prepared to receive TENDERS for the supply of CANNEL, COAL, and Cannel Slack or Nuts, for the next One, Three, or Five years.

Tenders, endorsed "Tender for Coal, &c." and addressed to the Chairman of the Committee, must be delivered on or before Saturday, the 10th of June next.

Further particulars may be obtained from HENRY GREEN, Engineer.

Gas-Works, Preston, May 12, 1876.

SHREWSBURY GASLIGHT COMPANY.

TENDERS FOR GAS COALS.

THE Directors are prepared to receive TENDERS for the supply of 6500 to 7000 tons of the best description of screened GAS COALS, for One or more years, as may be determined upon by the Directors.

The Coals to be as free as possible from sulphur, bats, bind, refuse, and dirt, and delivered free, by and at the expense of the Contractor, at the London and North-Western or Great Western Goods Station, Shrewsbury.

Tenders, specifying the Coals and the pits at which they are to be raised, must be delivered on or before the 1st day of June next.

The lowest or portion of any tender will not of necessity be accepted.

Payments monthly.

S. B. DARWIN, Secretary.

ENNISKILLEN GASLIGHT COMPANY.

TENDERS FOR COALS.

THE Directors of the Enniskillen Gas- light Company are desirous of receiving TENDERS for the delivery at Dundalk of about 900 Tons of Best GAS COAL, according to the times, or thereabouts, and the quantities, as mentioned in the following schedule:—

July	150 tons.
September	150 ,,
October	150 ,,
November	200 ,,
February	250 ,,

Cash payments, according to weight, as delivered at Dundalk.

Forms of tender, and any further particulars, to be had on application to Mr. GEORGE DUNBAR MALAM, Gas-Works, Bingley, YORKSHIRE, to whom tenders are to be sent not later than the end of the first week in June.

BOLTON CORPORATION—GAS DEPARTMENT.

CONTRACTS FOR CANNEL AND COAL.

THE Gas Committee are desirous of receiving TENDERS for CANNEL and best GAS COAL for the year commencing the 1st of July next, to be delivered free at the Bullfield or Craddock Lane sidings of the Lancashire and Yorkshire Railway, at Bolton, or if carted, at the Gas Street or Lum Street Works, as may be required.

Sealed tenders, endorsed "Tender for Coal," specifying the description of the Cannel or Coal, the pits at which they are to be raised, and the quantities proposed to be supplied, to be sent to the undersigned on or before Monday, the 29th inst., stating also cash terms for monthly payments.

The Committee do not bind themselves to accept the lowest or any Tender; but the person or persons whose Tende may be accepted will be required to execute an agreemen for the due performance thereof.

By order,
R. G. HINNELL, Town-Clerk.

Gas Offices, Bolton, May 5, 1876.

TENDERS FOR GAS COALS.

THE Directors of the Canterbury Gas and Water Company invite TENDERS for the supply of 5000 tons of best GAS COALS, to be delivered as follows:—

800	tons during the month of	June	next.
800	,, ,, ,,	July	next.
800	,, ,, ,,	August	next.
600	,, ,, ,,	October	next.
500	,, ,, ,,	November	next.
500	,, ,, ,,	December	next.
500	,, ,, ,,	January	next.
500	,, ,, ,,	February	next.

Persons tendering to state the name and guarantee the description of the Coal proposed to be supplied, and the price per ton, either free on board, or delivered at the Contractor's sole expense into the Company's coal store, the weight in the latter case to be ascertained on the Company's weigh-bridge, and paid for accordingly.

Tenders, endorsed "Tender for Gas Coal," to be addressed to me, and delivered at the Company's Offices, Castle Street, Canterbury, before Ten o'clock in the forenoon of Friday, the 2nd of June next.

The Directors do not bind themselves to accept the lowest or any tender.

By order,
JAMES BURCH, Secretary.

Canterbury, May 19, 1876.

T. NEWBIGGING,

CONSULTING GAS ENGINEER,

5, NORFOLK STREET, MANCHESTER.

D. M. NELSON,

48, GORDON STREET (late 135, BUCHANAN ST.),

GLASGOW,

Supplies every requisite in connexion with the distribution of Gas and Water.

Estimates and prices on application.

WOOD GRIDS for Purifiers and Scrubbers.

Cast-Iron PIPES and VALVES.

Street LAMP-PILLARS.

Patent Pipe SCREWING-MACHINES, &c.

TO INVENTORS AND PATENTEES.

MR. W. H. BENNETT, having had considerable experience in matters connected with Gas, Water, and Sanitary Improvement, begs to say that he continues to assist Inventors in the perfection of their designs, and to obtain for them PROVISIONAL PROTECTION, whereby their invention may be secured for Six Months; or LETTERS PATENT, which are granted for Fourteen Years.

Patents completed, or proceeded with at any stage, thereby rendering it unnecessary for persons resident in the country to visit London.

Patents procured for Foreign Countries.

Information as to cost, &c., supplied gratuitously upon application to the Advertiser, 22, Great George Street, WESTMINSTER.

THE THAMES BANK IRON COMPANY,

(Successors to LYNCH WHITE,)

SUPPLY FROM STOCK

CAST-IRON RETORTS, SOCKET-PIPES for GAS or WATER PURPOSES, FLANGE-PIPES for STEAM, RAIN-WATER PIPES and GUTTERS, HOT-WATER PIPES and BOILERS, and all requisite Connexions for same; also LAMP-COLUMNS, LAMPS, WROUGHT FRAMES, WROUGHT-IRON TUBING, &c., &c.

All kinds of Gas-Works Apparatus and General Castings made to Pattern or Drawing.

ADDRESS—

OLD BARGE WHARF, UPPER GROUND STREET, LONDON, S.E.

JAMES MILNE & SON,

GAS ENGINEERS,

Gas-Meter, Gas Apparatus, and Gas-Fittings Manufacturers,

EDINBURGH, AND

2, KING EDWARD STREET,

NEWGATE STREET, LONDON.

Meter Works in London—2, CROSS STREET, WILDERNESS ROW, E.C.

STATION-METERS, GOVERNORS, CONSUMERS METERS, GAS LUSTRES, CHANDELIERS, BRACKETS, &c.,

And every description of Gas-Fittings and Gas Apparatus.

TO GAS COMPANIES AND THE TRADE.

J. DEFRIES & SONS,

MANUFACTURERS OF

CRYSTAL, BRONZED, & ORMOLU CHANDELIERS, IMPROVED CRYSTAL STAR & SUN LIGHTS, VESTIBULE LAMPS, AND THE PATENT CRYSTAL ILLUMINATION.

A LARGE STOCK ALWAYS IN HAND OF

IRON, BRASS, COMPOSITE, AND LEAD TUBES, FOR GAS AND WATER,

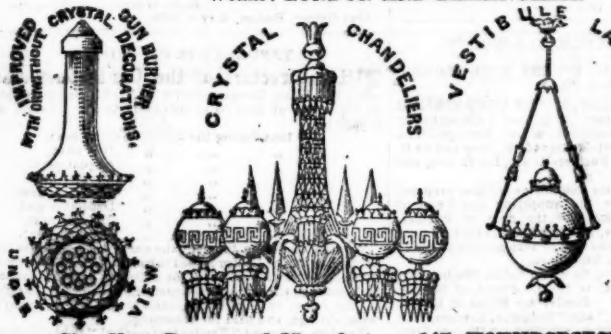
AND EVERY DESCRIPTION OF

GAS AND WATER FITTINGS.

THE PATENT DRY AND WET METER, WITH THE LATEST IMPROVEMENTS.

STREET LAMPS AND COLUMNS IN GREAT VARIETY.

WORKS: LONDON AND BIRMINGHAM.



GAS MOONS,
Cut and Engraved, of the newest designs

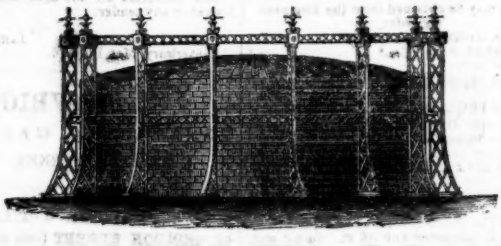
GAS REFLECTORS
In Silver and Glass

GAS NIBS AND BURNERS
Of every description.

Pattern-Books of Gas-Fittings, Crystal and Ormolu Chandeliers for 1876, are now complete.

City Show-Rooms and Manufactory, 147, HOUNDSDITCH, LONDON.

ESTABLISHED 1830.



THE HORSELEY COMPANY,

LIMITED,

TIPTON, STAFFORDSHIRE.

LONDON OFFICE:

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GAS ENGINEERS, IRONFOUNDERS, &c.,

MANUFACTURERS OF

GASHOLDERS, WROUGHT AND CAST IRON TANKS, CONDENSERS, PURIFIERS, SCRUBBERS, MAINS, RETORT-LIDS, PLAIN AND DISHED, LAMP-POSTS, PIPES,

AND ALL REQUISITES FOR EITHER

GAS OR WATER WORKS;

ALSO

MAKERS OF ROOFS, BRIDGES, &c.

Mr. ALFRED LASS,

60, CORNHILL, LONDON, E.C.,

Is prepared to open the Books, and, if necessary, keep the Accounts of Gas and Water Companies.

To examine the Books and Accounts, and prepare Balance-Sheets for the information of Directors.

To assist Secretaries in preparing Balance-Sheets, according to the "Gas-Works Clauses Act, 1871;" or may be consulted with respect to Accounts generally.

Just published, price 10s. 6d.,

REGISTRATION OF DISTRIBUTORY PLANT.

The forms for this purpose are to illustrate the Paper on Distribution of Gas, read at the Edinburgh Meeting of the British Association of Gas Managers. By the use of the synopsis the whole of the out-door plant may at once be seen, with all matters pertaining to the same.

W. J. WARNER, Engineer.

South Shields.

G. A. BAILEY AND CO., Machinists, Manufacturers of all kinds of Indexes for Gas and Liquid Meters, Tell-Tales for Turnstiles, on an improved principle. Every description of Wheel and Worm Cutting any size, &c.

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Manufactory for every description of Casting and Machinery for Gas-Works and Water-Works.

Warehouse in London for Cast-Iron Pipes and Connexions of all sizes and in any quantity, Scott's Wharf, Bankside, Southwark.

Agent in London, Mr. J. MANWARING, 101 Cannon Street, E.C.

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MANUFACTURERS OF

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SCOTSWOOD FIRE-BRICK WORKS,

SCOTSWOOD-ON-TYNE.

PLUTONIC CEMENT,

For Repairing Gas-Retorts in Action, preventing Porosity, and reducing the Deposit of Carbon, is highly commended.

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CHARLES HENRY STREET AND BISSELL STREET, BIRMINGHAM.

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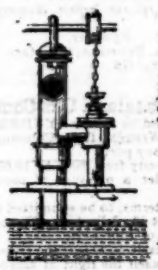
GAS-RETORTS, GLASS-HOUSE FURNACE, BLAST-FURNACE, TANK BRICKS, LUMPS, TILES,

And Every Description of Best Fire-Bricks.

COPP'S PATENT ANTI-DIP GAS APPARATUS.



Produces from 10 to 20 per cent. more gas of higher illuminating power.

Prevents the deposit of carbon.

Retorts last much longer.

Charges work off quicker.

This simple invention has been in use in many works for the last six months, with the above results.

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Testimonials and particulars on application.

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Our New and Choice Designs for the above, with prices, are forwarded to any part of the world on receipt of twelve stamps. Estimates for work at home or abroad.

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WOOD PURIFIER SIEVES,

Which have now been used for fifteen years, and their advantages and durability fully established. They are made entirely by steam machinery in very large quantities at the most moderate cost.

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CLOTH GAS-BAGS FOR MAINS,

As supplied to the Imperial, Chartered, and other London and Provincial Gas Companies. Bellows and Valves for inflating Well Dresses, Stokers Gloves, India-Rubber Suction and Delivery Hose, Gas-Tubing, Leather India-Rubber and Gutta-Percha Machine-Bands, Sheet and Washers and Steam Joints.

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TAR PUMPS,
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Portable or Fixed for Hand or Power.
SYPHON PUMPS.

Price, as engraving, with
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With bow-handle . . . . 16s. 0d.

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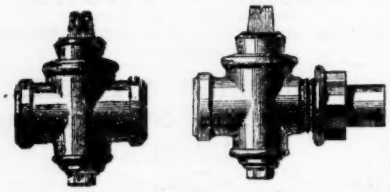
LAMBERT'S
CAST-IRON GAS-MAIN COCKS,
WITH PATENT WHITE METAL PLUGS.

TRADE (L) MARK.

No. 758. No. 759.



The bodies of these Taps are made of iron, black or galvanized, and the plugs of patent metal. They are warranted not to set fast or corrode, as do Iron or Brass Cocks; will always work easily; are strong, well made, durable; of little or no intrinsic value, and therefore not likely to be stolen; and the prices as stated below are (especially upon the larger sizes) fully 50 per cent. less than Brass Cocks.

	½	¾	1	1¼	1½	2-inch.
No. 758, with inside screws for iron pipe, black	2/0	3/0	4/4	6/6	7/6	12/0 each.
No. 759, with union on one end screwed inside for iron pipe, black	2/9	3/10	5/4	8/0	9/0	15/6 each.
Nos. 758 and 759, galvanized	0/3	0/4	0/6	0/8	0/10	1/4 extra.

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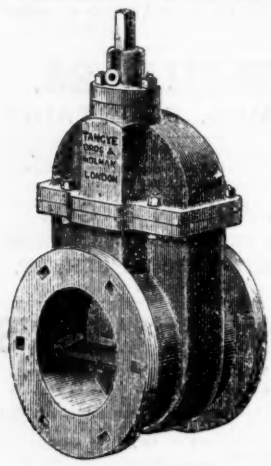
IMPROVED
GAS-VALVES,
AT GREATLY
REDUCED
PRICES.



Inch.	s.	d.
3	25	0
4	36	0
5	40	0
6	54	0
7	63	0
8	80	0
9	85	0
10	100	0
12	120	0
14	140	0

TANGYE BROS. & HOLMAN,
LAURENCE POUNTNEY LANE,
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Steam-Jet Engineers,
SOLE LICENSEES FOR
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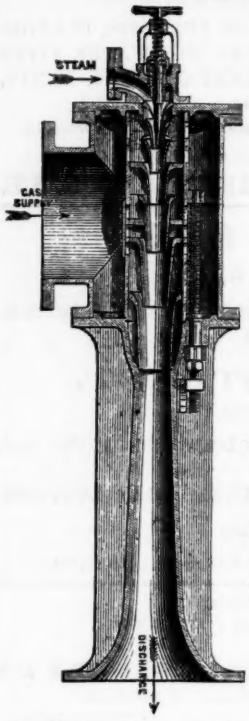

E. KÖRTING'S PATENT
STEAM-JET GAS-EXHAUSTER.

Small Cost—Compactness—Perfectly Self-Acting—
Self-Regulating—Self-Cleansing—No Steam-Engine—No Attention—
No Extra Room Required—No Wear and Tear—No Noise—
No Oscillation in Vacuum, or Back Pressure.

UPWARDS OF 200 IN USE.
SUPPLIED TO—

Chartered Gas Co.	Horsham Gas Co.	Bury Gas-Works.
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Phœnix Gas Co.	Cheltenham Gas Co.	Stalybridge Gas-Works.
Liverpool Gas Co.	Sandwich Gas Co.	Lincoln Gas-Works.
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E. KÖRTING'S PATENT STEAM-JET REVIVIFYING BLOWERS FOR THE PURIFYING MATERIAL.

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Combining small cost and thorough efficiency, with absence of any mechanical means and necessity of renewing the scrubbing material.

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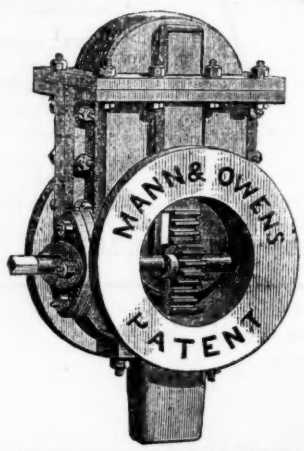
LONDON,
SOLE AGENT FOR ENGLAND AND WALES.

MANN & OWENS' PATENT GAS-VALVE.



RACK AND PINION VALVE.

SCREW VALVE.

The advantages of this Patent Valve over all others yet introduced are, that it is always as tight as the best wedge or spring valve, without the possibility of setting fast or becoming suddenly leaky. The surfaces not being in contact during the operation of opening or closing, leakage through wear and tear is avoided.

The Gas Engineer will not fail to see the importance of such a valve in connexion with his purifying apparatus, particularly in the case of large sizes.

The slide being operated either by a screw and nut, or by a pinion and rack, a cam bearing upon a plane, cast on the back of the Valve, forces it against the face, and renders the escape of gas an impossibility. By a slight turn of the pinion or screw, the slide is released, and brought away from the face, by which means friction is avoided, and the only force required to open the Valve is that due to its own weight.

SOLE MANUFACTURERS:

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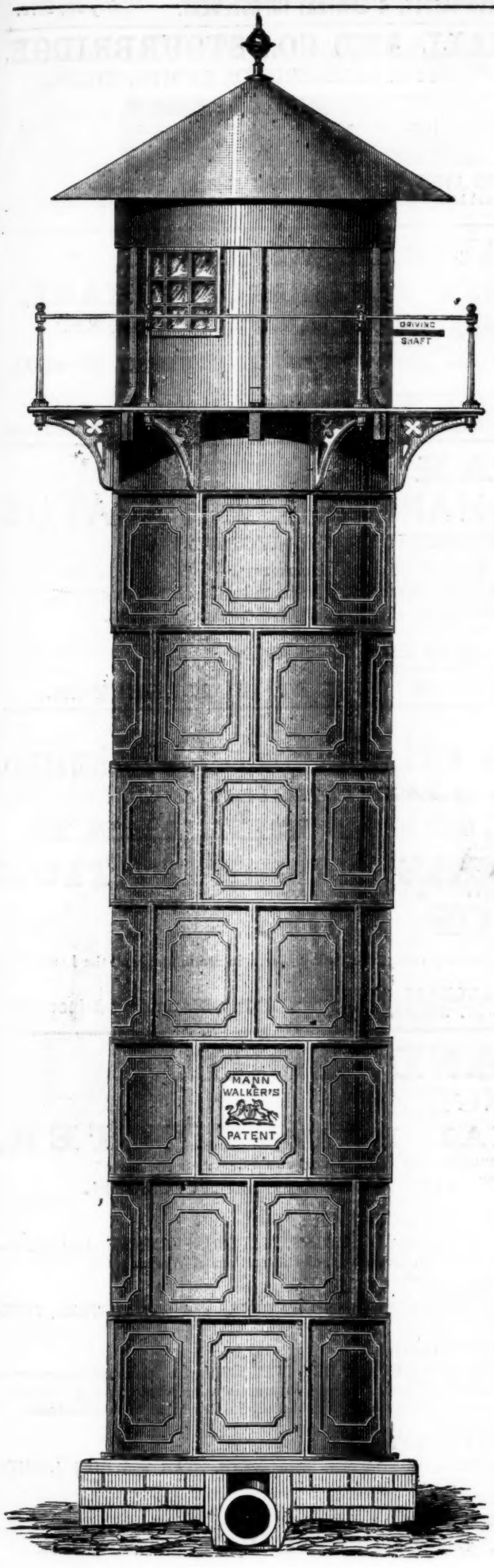
PRICES, SIZES AND FULL PARTICULARS ON APPLICATION.



C. & W. WALKER,
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MANN & WALKERS' PATENT SCRUBBER.

By Letters Patent in Great Britain, Europe, and the United States of America.

By some important improvements recently patented, the purifying power of these Scrubbers has been much increased, and a stronger ammoniacal solution obtained, which is found to absorb a large portion of the carbonic acid contained in gas, effecting an important saving in money and labour in the lime purifiers, and where oxide only is used, the increase in the illuminating power of the gas obtained by these Scrubbers is shown in a remarkable degree, in consequence of the large quantity of carbonic acid removed from the gas.

It is to be particularly noted that the important results of these Scrubbers do not depend upon the machinery alone. The entire internal construction of the Scrubber bears an almost equally important part. For this reason, where it is desirable to convert existing Scrubbers, whose dimensions happen to be suitable, the work commences by ripping out the whole of the interior of the shell, and beginning the internal construction *de novo* from bottom to top.

They are, in all cases, constructed under guarantees to perfectly perform their work. They are now extensively used in the largest gas-works of London and the chief cities of Europe, the number in use exceeds **one hundred,** and their perfect efficiency and profit to a gas company have been fully established with every variety of coal used in Europe. References can be given to the largest gas-works in Europe.

By their use the department of purification from ammonia upon a gas-works is made complete, without the aid of prepared oxide of iron, chemicals in purifiers, or any other supplementary process, and the whole ammoniacal residual product contained in the coal is absorbed and obtained in the form most profitable to a gas company, while the requirements of all Acts of Parliament and of the Board of Trade, relating to incorporate gas companies, are satisfied.

Foul Gas, properly condensed, entering the inlet is, by once only passing through the Scrubber, completely purified from ammonia with regular certainty day by day, without any further trouble, or any other process, effected by a very small quantity of clear water let into the machinery room at the top of the Scrubber, which is discharged at the liquor outlet at the bottom, from Newcastle coal at about 18 to 20 ounces strength, from Yorkshire and other coals, generally from 25 to 30 ounces strength; while acidulated litmus or turmeric exposed at the Scrubber outlet will not show the slightest discoloration, and there is not a quarter of a grain of ammonia per 100 feet left unabsorbed.

They contain their own engine power, requiring only a small inappreciable quantity of steam from the gas-works boiler, and are then complete in themselves, ready for service.

Applications relating to dimensions and prices should be addressed to us, C. and W. Walker, 8, Finsbury Circus, London, E.C., or to Mr. William Mann, late Superintendent of the Chartered Gas-Works, Blackfriars, London; they should state approximately the largest make of gas in 24 hours on a winter's day, and the smallest make on a summer's day, to be purified.

BAILEY'S Patented Inventions are now in extensive use wherever steam is known. Bailey's Patent Steam Gauges, Pyrometers, Water Gauge Cocks, Test Pumps, Fusible Plugs, Steam and Water Valves, Safety Valves, Junction Valves, Pumps, Tell-Tales, Recorders, Lightning Conductors, Electric Telegraphs, Turret Clocks, Steam Joint Cement, Lifting Jacks, Boiler Feeders, Lime Catcher and Separator, Injectors and Ejectors, and every description of first-class Brass Work for Engines and Boilers. Gas-Works Managers who have not our large book should send for it.

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PRIZE MEDAL
For excellence of Fire-Clay Gas Retorts, and
"HONOURABLE MENTION" for
good quality of Fire-Bricks.

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Manufacturers of FIRE-BRICKS, LUMPS, TILES,

AND EVERY DESCRIPTION OF FIRE-CLAY GOODS.
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GAS ENGINEER AND CONTRACTOR FOR THE ERECTION OF GAS-WORKS,
AND FOR THE
SUPPLY OF RETORTS, FIRE-BRICKS, CAST-IRON MAINS,
AND ALL MATERIALS FOR GAS MANUFACTURE AND DISTRIBUTION.

WHITAKER'S
PATENT RETORT CHARGING APPARATUS
(NOW AT WORK AT WAKEFIELD GAS-WORKS)
Effects a Great Saving in Labour,
Renders Gas Companies less Dependent on Skilled Stokers,
And can be Supplied and Erected at a Moderate Cost.
FOR FURTHER PARTICULARS, APPLY TO THE SOLE LICENSEE.
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GAS PURIFICATION & CHEMICAL Co., LIMITED,
(Successors to JOHN WILLIAM O'NEILL & CO.,)
Offices—PALMERSTON BUILDINGS, OLD BROAD STREET, LONDON, E.C.,
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The superiority of the material supplied by this Company is generally recognized, and it is now in use in nearly all the London and most of the large Provincial Gas-Works.

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WORKS: COMMERCIAL ROAD, EXETER,
INVITE THE ATTENTION OF GAS COMPANIES AND OTHERS FOR THE SUPPLY OF
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NEW GAS-WORKS erected complete. Plans and Estimates furnished. MAINS, METERS, SERVICES, LAMPS, &c., adapted for Towns of any size. Gas Companies advised on Improvements, Extensions, and Alterations of Works.

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They beg special attention to the excellence and superiority of their WET and DRY METERS, several thousand being now in use by many of the largest Gas Companies in the West of England and South Wales. Warranted to measure correctly, and not to vary. Their acknowledged superiority has brought them into general use more rapidly than any Meters hitherto manufactured. A guarantee of Five years tendered with each Meter.

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1862.

PATENT ANTIMONY PAINT.

MADE ONLY BY

GEORGE HALLETT & CO.,

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CLASS II.

1862 LONDINI HONORIS CAUSA

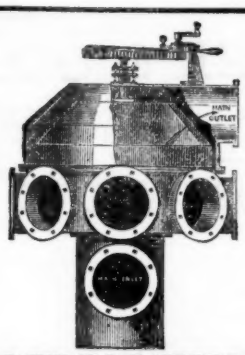
This Paint having been in general use over fourteen years (especially in some of the principal Gas-Works), and proved itself the best light-coloured Paint produced for resisting the influence of vitiated atmospheres, it is important that its qualities should be more widely known.

It is not discoloured like white lead in a sulphuretted atmosphere, nor washed off like white zinc; and its light colour reflecting heat, produces much less expansion of gas in holders painted with it than with dark colours, besides rendering them much more sightly. Its specific gravity is so much below white lead that the same weight will cover one-third more surface, while it is equal in body; and its price being about the same (30s. per cwt.), it is actually one-third cheaper. From experience, its manufacture is greatly improved, and it is quite suitable for all purposes in which white lead is employed.

The following Gas Companies in London have used the Paint for years—viz., The Gaslight and Coke, Imperial, Independent, City of London, Commercial, London, and Surrey Consumers.

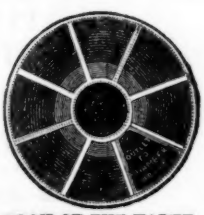
N.B.—Antimony Paint, COVERING SO MUCH MORE WORK, costs about 20s. per cwt., as compared with White Lead at 30s. per cwt.; a similar economy arises from its use in Steam and Gas Joints, for which purpose it is superior to White Lead.

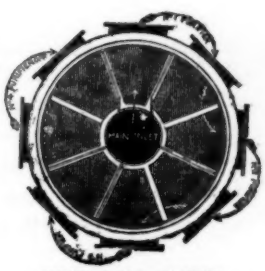
SPECIAL DRIERS FOR ANTIMONY PAINT SUPPLIED.



C. & W. WALKERS'

PATENT CENTRE-VALVES.

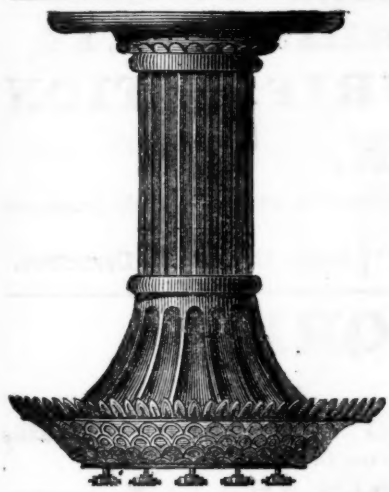




ELEVATION OF THE CENTRE-VALVE. PLAN OF THE VALVE. PLAN OF THE BODY.

These PATENT CENTRE-VALVES are the most perfect and certain means for working Purifiers on the system of three in action, and one out of action. The Valve itself is protected from all injury inside the safety cover. The working of the Valve is so easy, and so governed by the stop-catch movement, that the Purifiers can be instantaneously changed in the dark as well as in daylight. They are scraped perfectly true, metal to metal, the facings heretofore exposed are always covered, and there is nothing more reliable, certain, and durable in a gas-works. By their use the floor of the Purifying-house is clear and level; the Valve and all connexions being beneath the floor, out of the way of working. A considerable improvement and saving is effected in the cost of the connecting-pipes.

MIDLAND IRON-WORKS, DONNINGTON, near NEWPORT, SHROPSHIRE; 8, FINSBURY CIRCUS, LONDON.



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GAS AND HOT WATER ENGINEERS,

155, CANNON STREET, E.C.

Manufactory: 19 & 20, NICHOLAS LANE, E.C.

SUN-BURNERS,

With Regulating Valves to obviate down draught.

MEDIÆVAL & OTHER GAS-FITTINGS

For Churches and Domestic Use.

ARCHITECTS' OWN DESIGNS WORKED OUT.

ESTIMATES FREE OF CHARGE.

THE TRADE SUPPLIED.

SOLE CONSIGNEES FOR BRÖNNER'S IMPROVEMENTS IN GAS LIGHTING.

IN THE MATTER OF

BRÖNNER'S GAS-BURNERS.

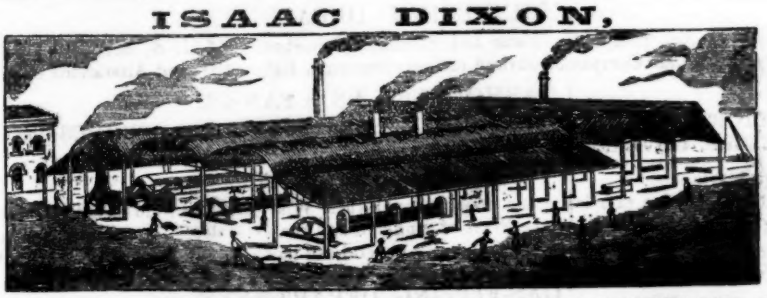
HENRY GREENE AND SON, 155, Cannon Street, London, Sole Agents for Great Britain, Ireland, and Colonies, of Brönner's Improvements in Gas Lighting, beg to inform the public that on the 13th of January, 1876, Julius Brönner obtained an injunction in the Court of Session, Scotland, against Donald M'Vean, Gas-Fitter, 14, Newton Street, Glasgow, prohibiting him from in any way advertising or offering for sale as Brönner's Burners, any Burner not manufactured by Julius Brönner, or from in any way inducing the public to believe that the said Donald M'Vean sells or keeps for sale Brönner's Burners, manufactured by Julius Brönner, while such is not the case.

Also that on the 9th of November, 1875, he obtained injunction in the same Court, and in the same terms, against E. M. Brechin and Co., 46, North Hanover Street, Edinburgh.

Also that on the 20th of April, 1875, in a suit in Chancery, before Vice-Chancellor Malins, number 1874, B 365, he obtained injunction against another defendant, in the same terms and on similar grounds.

ISAAC DIXON,

WINDSOR IRON-WORKS, LIVERPOOL.



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Manufacturer of SELF-SUPPORTING GALVANIZED CORRUGATED, CURVED, and every kind of IRON ROOFING, CHURCHES, SCHOOLS, SHEDS, and IRON BUILDINGS.

WROUGHT and CAST IRON GIRDERS, BRIDGES, TANKS, &c., and all kinds of WIRE WORK, FENCING, GATES, HURDLES, &c., for Home or Abroad.

DIXON'S CELEBRATED SELF-SUPPORTING IRON ROOFS are specially suitable for Forges, Rolling-Mills, Iron-Works, Shipbuilding Yards, Mines, Collieries, Gas and Water Works, and for general purposes.

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CATHELS'S Patent District Dry Gas-GOVERNOR is the only perfect self-acting contrivance for Regulating the Pressures in the higher levels of a district.

For prices, &c., apply to the Manufacturers, Messrs. GUEST AND CHRIMES, ROTHERHAM.

CATHELS & TERRACE'S Patent Four-WAY DISC GAS-VALVE is the simplest and best Valve for Purifiers, and as a By-pass for other apparatus in Gas-Works. It is always gas-tight, and has no springs, ground faces, or other delicate parts. By its use the flow of the gas cannot be accidentally stopped, and it never sticks.

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ANTI-CORROSIVE COMPOSITIONS. SZERELMEY IRON PAINT having been in use for upwards of twenty years, has stood the test of time. SIR CHARLES BARRY reported to the Chief Commissioner of Works (in 1859) that the Iron Roofs of the Westminster Palace, coated in 1856, "Still afford the most convincing and satisfactory evidence of its efficacy," and anyone who looks at the work now, in 1876, will see the same evidence.

THE Undersigned have, by means of extensive machinery and improved processes, succeeded in reducing the price of the Szerelmey Iron Paint, that which was formerly sold at £35 they now supply at £33, and make other kinds, commencing at £20 per ton, including Black, Purple, Chocolate, Red, Green, Blue, Bronze Green, Grey, White, and various tints.

THE Szerelmey Liquid Enamel, sold ready for use, is the cheapest Anti-Corrosive Composition ever produced; it dries in four hours.

SZERELMEY Stone Paint thoroughly waterproofs brick and other walls without giving them the appearance of having been painted.

COPIES of the Reports of Sir Charles Barry, Sir R. J. Murchison, and Professor Faraday (printed by order of the House of Commons), with twenty years of favourable testimony,

Price lists, discounts, and all particulars may be had of

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TORBAY AND DART PAINT COMPANY, LIMITED.

WORKS:
DARTMOUTH AND BRIXHAM, DEVON.

OFFICES:
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SOLE PROPRIETORS AND MANUFACTURERS OF
WOLSTON'S CELEBRATED

TORBAY IRON PAINTS.

(ESTABLISHED 1851.)

TRADE MARK

These Paints have been for many years extensively used in Her Majesty's Royal Dockyards, Woolwich Arsenal, the Shorncliffe and Curragh Camps, War Departments, and Colonies, and are largely supplied to Railway, Harbour, and GAS COMPANIES, Shipowners, Engineering Establishments, Railway Carriage and Waggon Works, and the Paint Trade generally. They are the BEST PROTECTORS of IRONWORK, even arresting corrosion after it has set in; and their base being oxide of iron, they are free from those properties which make lead paints so destructive to ironwork. They do not scale or blister, are not affected by great heat, and are the only Paints which will resist the effects of sulphuretted hydrogen. Their DURABILITY and covering properties have borne the test of A QUARTER OF A CENTURY'S PRACTICAL TRIAL.

The undermentioned colours—ground in best linseed oil, and requiring only before use to be thinned down in the ordinary way—are kept in stock:—

Torbay Brown.	Torbay Red.
Dart Green.	Slate.
Dart Yellow.	Buff.
Brixham Black.	Torbay Chocolate.
Light Blue.	Cream Colour.
Dart Brown.	Dart Umber.
Imperial Stone.	Light Stone.
Bronze Green.	Salmon Colour.
Navy Green.	Lead.
Carriage Red.	Dark Stone.
Light Lead.	Crystal Palace Blue.
Light Green.	Iron Grey.

All other Colours made to order.

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GAS ENGINEERS,
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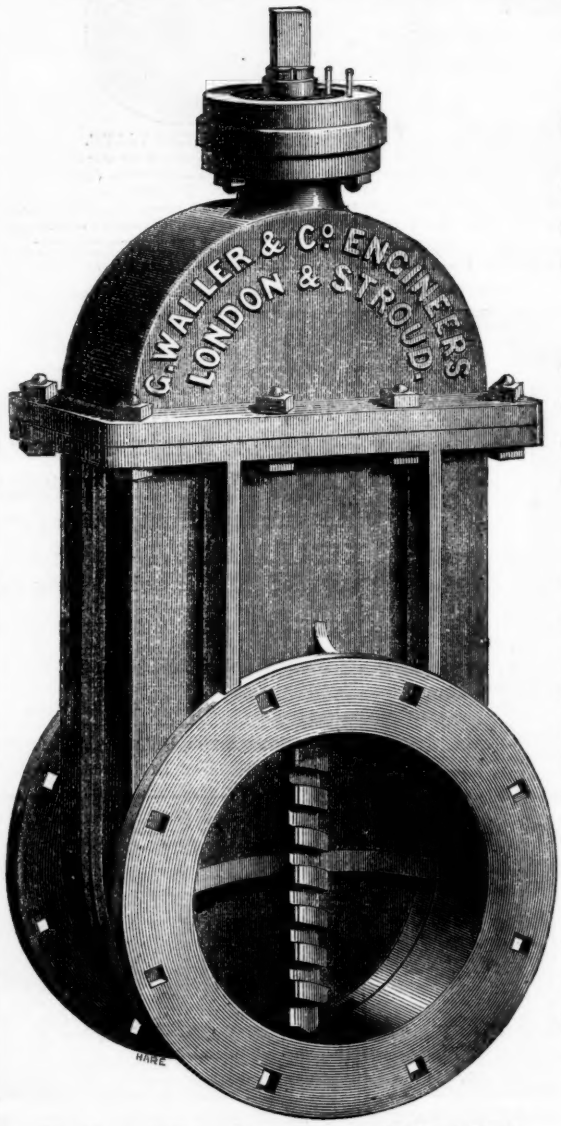
ESTIMATES FOR GAS-WORKS OF ANY SIZE.
REFERENCES TO 500 WORKS ALREADY ERECTED.

N.B.—It is most particularly requested that all Communications be addressed to the FIRM ONLY, as circumstances have arisen which render this necessary.

GEORGE WALLER & CO.,

GAS ENGINEERS AND CONTRACTORS.

IMPROVED INDEX GAS-VALVE.



The Door of Valve has a Circular Wedged Back.

G. WALLER & CO.

Were the first manufacturers of Gas-Valves with Circular Wedged Backs.

The springs are to clear off any dirt from the face of door when closing. **The body is cast in one piece.**

These Valves are proved on both sides to 30 lbs. per square inch. The worm keeps the door open at any point, and clears out any dirt in the rack. One man can open the largest Valve without extra gearing. The Index on top has large studs to show how much the Valve is open, and they can be **readily felt in the dark.**

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AND AT
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MANUFACTURERS OF

WET & DRY CONSUMERS GAS-METERS,

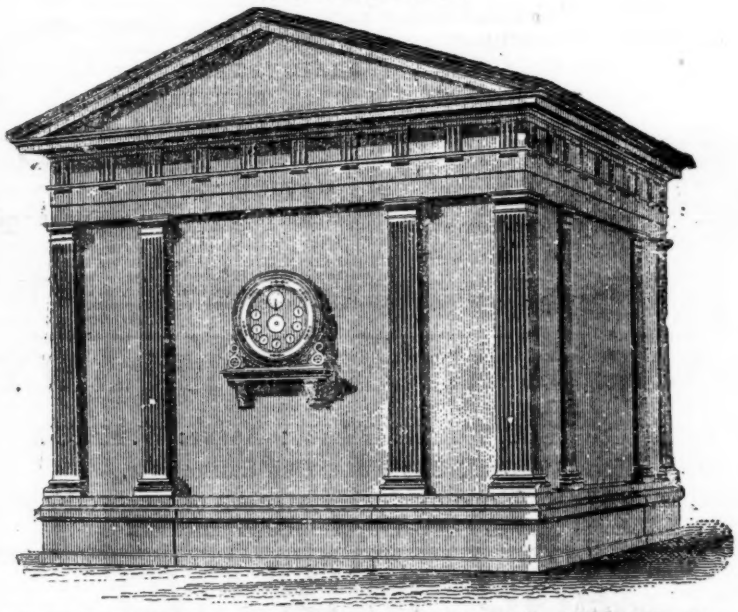
OF THE HIGHEST EXCELLENCE ONLY;

ALSO LICENSEES AND MANUFACTURERS OF

WARNER & COWAN'S PATENT SELF-REGULATING GAS-METERS;

ROUND STATION-METERS,

ON CAST-IRON STANDS.



SQUARE STATION-METERS,

WITH PLANED JOINTS.

GOVERNORS, GAUGES, INDICATORS, MAIN COCKS, &c.

GAS COOKING APPARATUS.

Home and Foreign Orders promptly attended to.

All Sizes of CONSUMERS METERS, STATION-METERS, and GOVERNORS generally in Stock.

Orders almost invariably despatched on the day of receipt.

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WALL LIGHTS, AND LUSTRES FOR GAS AND CANDLES.

TABLE GLASS OF ALL KINDS.

CHANDELIERS IN BRONZE AND ORMOLU. MODERATOR LAMPS.

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RETORT SETTINGS—giving great Economy of Fuel.

STEAM-ENGINES and EXHAUSTERS, FOUR-WAY VALVES.

FUEL-MACHINE, for Compressing Breeze and Tar.

WASHERS, SCRUBBERS, and PURIFIERS, that Economize Space and Cost.

N.B.—Pamphlet, with Eighteen Illustrations of the foregoing, with letterpress on the construction of Gas-Works, post free, 2s. 6d.

WATER-MAINS.

COTTERILL'S PATENT STEEL TUBE-

DRILLS, for connecting services to water-mains, *under pressure*, without turning off the water. They drill and tap themselves, and are left in the mains. Made of all sizes, from ¾ to 2 inches and upwards. They cost less than the ordinary plan.

Apply to CHARLES FORSTER COTTERILL, Cannock, STAFFORD, Patentee.

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WILLINGTON QUAY,

NEAR NEWCASTLE-UPON-TYNE,

Manufacturer of

CLAY RETORTS, FIRE-BRICKS, AND EVERY DESCRIPTION OF FIRE-CLAY GOODS

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Manufacturers of GAS-RETORTS, GLASS-HOUSE FURNACE & BLAST-FURNACE BRICKS LUMPS, TILES, and every description of FIRE-BRICK.

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BEST GLASS-HOUSE POT and CRUCIBLE CLAYS.

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THE ORIGINAL MANUFACTURER OF

WOOD SIEVES

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WITH TAPER BARS,

MADE BY MACHINERY

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PREVENTS WASTE OF GAS FROM RETORTS;

SAVES CLAY RETORTS FROM DESTRUCTION BY FIRE;

GREATLY ECONOMIZES THE USE OF FIRE-BRICKS;

And PREVENTS ALL POSSIBLE LOSS of GAS FROM LEAKAGE.

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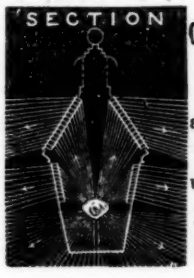
CAST-IRON GAS AND WATER PIPES.

DELIVERY F.O.B. ON CLYDE, OR STOCKTON-ON-TEES.

Prices on application.



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CATOPTRIC LAMP

Is now in use in Moorgate Street, Cheapside, and Trafalgar Square, and has been in successful operation upon Waterloo Bridge since Oct. 7, 1871.

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LOTHIAN'S CANNEL
Yields 12,500 cubic feet of 34-candle gas per ton, and 9 cwts. of excellent coke, containing only 4 per cent. of ash.

MUIRKIRK, No. 1, CANNEL
Yields 12,160 cubic feet of 32·5-candle gas per ton, and 10 cwts. of excellent coke, containing only 5 per cent. of ash.

OLD WEMYSS CANNEL
Yields 13,320 cubic feet of 32·5-candle gas per ton.
Prices and full Analyses on application.

THE
FRAMWELLGATE COAL COMPANY,
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Are prepared to supply their
SCREENED AND NUT GAS COALS.
This Coal yields 11,000 cubic feet of gas and 13½ cwts. of coke per ton.
OFFICES: ROYAL EXCHANGE, MIDDLESBROUGH.

HEBBURN MAIN GAS COALS.

Cubic feet of Gas yielded per ton . . .	10,050
Illuminating power in sperm candles . .	15·4
Yield of coke per ton of good quality . .	13¾ cwts.

THE TYNE COAL COMPANY, LIMITED, OWNERS.
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GAS COAL.
POPE & PEARSON, LIMITED, have now the authority of several of the most eminent Gas Engineers of London in stating that their Coal yields *in practical working over* 10,000 *cubic feet of gas, with an illuminating power of* 16 *candles;* or by the standard burners now used by the London Gas Companies, an illuminating power equal to 17½ candles.
One ton yields 12½ cwt. of good coke. This Coal can be shipped from Hull, Goole, Liverpool, Morecambe, and Barrow.
For further particulars, apply to POPE AND PEARSON, LIMITED, West Riding and Silkstone Collieries, near LEEDS.

SCOTCH CANNEL COALS.
The Subscriber is prepared to contract for the supply of all the principal SCOTCH CANNEL COALS. Prices and Analyses of the various Coals will be forwarded on application.
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CANNEL COAL MERCHANT,
HAYMARKET, EDINBURGH.
Established 1840.

C. T. GRANT & CO. COAL BROKERS GLASGOW.
Scotch Churls
PRESENT PRICE:
5s. 6d. per Ton at Pit.
8s. 9d. ,, F.O.B.
Cubic Feet. 10,000 .. Illuminating Power. 20 candles. .. Coke (sup. qual.). 12 cwt.

CANNEL COAL.
COPPA COLLIERY, MOLD,
Beg leave to call the attention of Gas Companies to the superior quality of their
CANNEL FOR GAS-MAKING PURPOSES.
This Cannel produces in actual working, in iron retorts, 9200 cubic feet of 32-candle gas, and upwards of 11 cwt. of coke, and in clay retorts will produce 11,500 cubic feet of 25·9-candle gas.
Ports of shipment—Birkenhead or Connah's Quay.
Waggons supplied for delivery by railway to any part of England or Wales.
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LESMAHAGOW
MAIN SEAM CANNEL COAL.
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Analysis and Price on Application.

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ALFRETON IRON-WORKS, DERBYSHIRE,
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WENLOCK IRON WHARF, 21 & 22, WHARF ROAD, CITY ROAD, LONDON, N.,
Keep in London and at their works large stocks of PIPES and CONNEXIONS (1½ to 36 inches in diameter); also make and supply Retorts, Tanks, Columns, Girders, Special Castings required by Gas, Water, Railway, Telegraph, Chemical, Colliery, and other Companies.
CHARLES HORSLEY, Agent.

THE WIGAN COAL & IRON COMPANY,
LIMITED,
DISTRICT OFFICE: 18, BENNETT'S HILL, NEW STREET, BIRMINGHAM; AGENT: W. M'GOWAN;
Supply the Best Wigan Arley Mine Gas Coal, Gas Nuts, Gas Cannel, &c.
N.B.—The Wigan Coal and Iron Company, Limited, are exclusive owners of the well-known HAIGH HALL AND KIRKLESS HALL GAS COAL COLLIERIES.

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GAS COAL & CANNEL.
EMOR G. WRIGLEY
Has on hand a quantity ready for immediate delivery, and is prepared to contract for Supplies during the years 1876 and 1877.
Can strongly recommend his real OLD SILKSTONE GAS COAL, which will give, in regular work, 10,200 feet 16·6-candle gas, and 12 cwt. superior coke.
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THORNCLIFFE IRON-WORKS AND COLLIERIES,
NEAR SHEFFIELD,
STRONGLY RECOMMEND A TRIAL OF THEIR
CELEBRATED SILKSTONE GAS NUTS.
Analysis by F. J. EVANS, Esq., Chartered Gas Company, Horseferry Road, Westminster:—
(COPY.)

	Cubic Feet of Gas per Ton of Coal.	Illuminating Power in Candles.	Coke per Ton of Coal used.	Ash in Coke, per Cent.	Sulphur in Coal, per Cent.
Silkstone Nuts . . .	10·800	15·85	12·66 cwt.....	6·0	0·69

NOTE.—The illuminating power of the gas was tested by the standard burner now used in London by the Gas Referees, under the City of London Gas Act, 1868.
Horseferry Road, Westminster, March, 1870. (Signed) F. J. EVANS.
These Nuts are extensively used by various Gas Companies throughout the Kingdom, who bear strong testimony to their value.
APPLICATIONS FOR PRICES, &c., TO BE SENT DIRECT TO THE COLLIERY, AS ABOVE.

THE SILKSTONE & DODWORTH COAL & IRON COMPANY, LIMITED,

DODWORTH, BARNSLEY.

BENJAMIN WHITWORTH, Esq., M.P. . . . . Chairman.
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REAL OLD SILKSTONE GAS COAL.

JAMES PATERSON, Esq., Gas Engineer, of the Warrington Gas Company, reported, Aug. 10, 1875:—
"This Coal possesses remarkable qualities as a gas and coking coal, and appears SECOND TO NONE IN THE KINGDOM. It contains the large quantity of 699 lbs. of illuminating matter, and 1498 lbs. of coke to the ton, and produces **12,240** cubic feet of 16·66 candle gas."

The above Company are raising nearly a thousand tons of the Real Old Silkstone Gas Coal per working day.

PRICES QUOTED TO ANY RAILWAY STATION, OR F.O.B. HULL, GRIMSBY, GOOLE, KEADBY, LIVERPOOL, AND FLEETWOOD.

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THE DERBYSHIRE
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CAN OFFER A

GAS COAL

Of superior quality, delivered at any station in England and Wales.

Purified gas per ton of coal in cubic feet (average)	10,775
Weight of coke in lbs. per ton of coal	1,465

ANALYSIS AND PRICES ON APPLICATION TO
Mr. EDMUND TAYLOR, Secretary,
ALBERT COLLIERY, NEWBOLD, NEAR CHESTERFIELD.

THE LOCHORE AND CAPLEDRAE CANNEL COAL COMPANY, LIMITED.

Works: LOCHORE by LOCHGELLY, FIFESHIRE. Office: CUSTOM HOUSE CHAMBERS, LEITH.

This Company request attention to the very superior quality of their Cannel Coals.

1. The following are the practical results given by Dr. Wallace, of Glasgow, of analyses of their Lochore and Capledrae Cannels:—

	Sample worked at Capledrae.	Sample worked at Lochore.
Gas per ton of coal, at 60° Fahr. and 30 inches barometric pressure . .	13,095 cubic feet.	11,760 cubic feet.
Illuminating power, in standard sperm candles, by union jet consuming 5 cubic feet per hour, at ·5-inch pressure	32·91	34·83
Value of 1 cubic foot of gas in grains of sperm	780	836
Equivalent of a ton of coal in pounds of sperm candles	1,459	1,404
Durability of 1 cubic foot by 5-inch flame	69 minutes.	71 minutes.
Gravity of the gas (air = 1000)	596	594

Remarks.—This (the sample from Capledrae) is a Cannel Coal of first-class quality, giving 13,000 feet of 33-candle gas. It contains only a minute proportion of sulphur, and the ash is almost quite white. The coke is of rather inferior quality.

Remarks on Sample from Lochore.—This is a Cannel Coal of first-class quality, giving a large yield of very rich gas and a coke of medium quality.

2. The following are the practical results of analyses by Dr. Wallace of the Company's Waverley Cannels:—

	Capledrae Waverley.	Lochore Waverley.
Gas per ton of coal, at 60° Fahr. and 30 inches barometer	9,120 cubic feet.	11,145 cubic feet.
Illuminating power, in standard candles, by union jet consuming 5 cubic feet per hour, at ·5-inch pressure	36·62	33·09
Value of 1 cubic foot of gas in grains of sperm	878	794
Equivalent of a ton of coal in pounds of sperm candles	1,145	1,264
Durability of 1 cubic foot of gas by 5-inch flame	80 minutes.	67 minutes.
Gravity of the gas (air = 1000)	677	597

Remarks on the Sample of Capledrae Waverley.—This Coal gives fully 9000 feet of gas of 36½ candles, and is admirably adapted for bringing up the quality of gas made from common coal or inferior qualities of cannel. The tests were made at a rather high temperature, this being one of the coals that stand a very high heat without serious diminution of the illuminating power of the gas The coke contains 60 per cent. of ash, and is therefore almost valueless, but the proportion of sulphur is very moderate.

Remarks on the Lochore Waverley.—This is a first-class Cannel Coal, giving 11,000 cubic feet of 33-candle gas. The quantity of sulphur is very minute, and the ash is nearly white. The coke is of inferior quality, but not wholly valueless.

Applications for full Copies of Analyses and Prices may be made to the Company.

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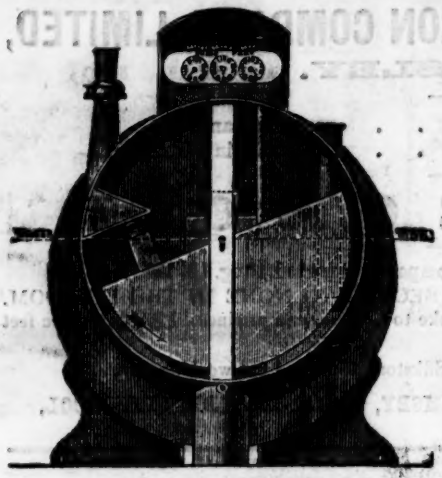

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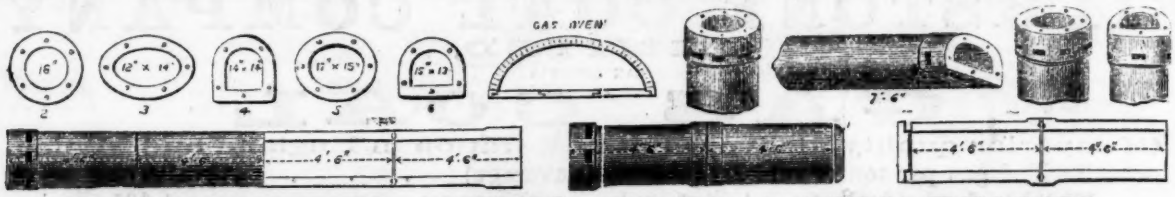

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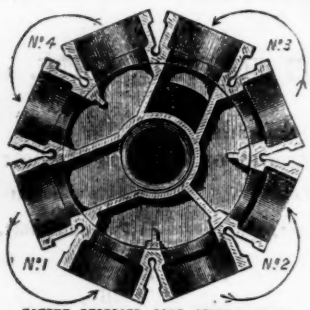

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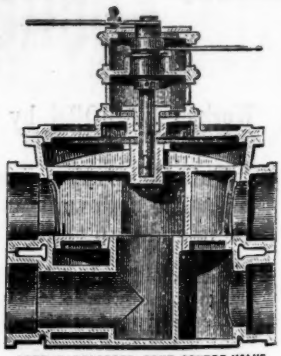

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